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THE SHOCK AND VIBRATION DIGEST

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Dr. R.L. Eshleman
Vibration Institute
Suite 206
101 West 55th Street
Clarendon Hills, Illinois 60514

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Henry C. Pusey
Director

Rudolph H. Volin

J. Gordan Showalter

Barbara Szymanski

Carol Healey

SVIC NOTES

The Acoustical Society of America (ASA) recently held its 50th Anniversary Celebration (1929-1979) at the semi-annual meeting in Cambridge, Massachusetts. I had the privilege of attending. As might be expected the thrust of the meeting was historical. A special feature of the technical program was a series of five plenary sessions with distinguished lectures planned to cover all aspects of the broad field of acoustics. Indeed, the study of acoustics covers a wide range of professional interests. ASA has spawned nine active technical committees, the names of which indicate the scope of the society: Architectural Acoustics, Engineering Acoustics, Musical Acoustics, Noise, Physical Acoustics, Psychological and Physiological Acoustics, Shock and Vibration, Speech Communication, and Underwater Acoustics.

The chairmen of these technical committees form the Technical Council which is well-structured to further the goals of the society. We who have principal interests in the shock and vibration area should not be troubled by our apparent role as a small subset of this large society. Our interests and our technology extend into several of the other technical areas mentioned above. Fundamentally, the great advantage of belonging to an organization like ASA is the opportunity for technical interchange among several related disciplines. As I viewed this conference, both from the standpoint of apparent attendance and technical offerings, ASA should be congratulated for the important place it fills in the scientific community.

There were three sessions at this historic conference related to shock and vibration. The first on computer applications in problems of shock and vibration was chaired by Dr. S.P. Ying, a newly-elected fellow of ASA. Dr. R.H. Lyon, a pioneer in the use of statistical energy analysis, organized and chaired a session on recent applications of this technique. Application areas included building acoustics, engines, shipbuilding, offshore structures, vibration isolation and airplane noise. Finally, Dr. Eric Ungar, recent chairman of the ASA Shock and Vibration Technical Committee, chaired a session primarily related to damping.

From an overall viewpoint, I consider the sessions to have been informative and useful. We look forward to the next ASA conference in Salt Lake City, Utah this November.

H.C.P.

EDITORS RATTLE SPACE

COMPUTATIONAL CATASTROPHES

I am concerned about the way many difficult physical problems, including many shock and vibration problems, are solved numerically nowadays with little concern by the analyst as to the quality, accuracy, and meaning of the solution. I maintain that modern computing machinery and numerical methods, put in the hands of well-meaning but technically naive individuals, can be dangerous. This is of particular concern during the present era in which much computer software is circulating that is purportedly designed for the analysis of complicated nonlinear problems in mechanics and physics.

To prove my point I am beginning to compile a scrapbook of innocent-looking little problems containing formidable pitfalls. My scrapbook is for those who think that most problems can be beaten to death with standard numerical methods and that no understanding of the qualitative behavior of the solution or its approximation is necessary. My first example is a relatively well-known one and will not fool some people; it is the simple two-point boundary value problem:

$$\frac{d}{dx}(1 - c\phi'^2)^{\frac{1}{\gamma-1}} = 0, \phi(0) = 0, \phi(1) = \beta \quad (\gamma = 1.4)$$

Another arises in wave mechanics and the study of a variant of Schrödinger's equation:

$$-u'' - \frac{1}{x}u' - u + \frac{1}{16}u^5 - u^3 = 0$$

$$u(\pm\infty) = 0, u'(0) = 0$$

The physically meaningful solution is a smooth, positive-valued, function decaying to zero as $|x|$ increases.

Those of you who have codes for solving such problems may wish to give them a try. I have some others, including a simple one-dimensional friction problem with a continuum of solutions; the physically meaningful solutions are exceedingly difficult to extract numerically.

Any contributions the reader would like to make to my scrapbook would be sincerely appreciated. I prefer simple looking ones, like those above, for if simple two-point boundary problems can cause such difficulties, it should be evidence enough that many of the large-scale nonlinear problems that are now being attempted numerically are virtual mine fields.

J.T. Oden
Texas Institute for Computational Mechanics
The University of Texas
Austin, TX 78712

RECENT DEVELOPMENTS FOR THE NONLINEAR DISTORTION OF NON-DISPERSIVE ACOUSTIC WAVES
Part I: Planar Waves and the Basic Method

J.H. Ginsberg*

***Abstract** - This two-part paper describes a perturbation procedure for investigating finite amplitude acoustic waves that depend on more than one spatial coordinate. The discussion focuses on wave motions that are non-dispersive in the linear approximation, in which case amplitude dispersion and self-refraction are the primary mechanisms for nonlinear distortion. Part I covers planar waves and the basic method. In Part II the results for a variety of systems are presented, and some types of further research are suggested.*

The role of nonlinearities in the generation and propagation of acoustical waves has obvious practical application, in addition to theoretical interest. The case of one-dimensional (i.e., planar) waves has been well explored by a variety of methods, including an exact solution by Earnshaw in 1858 [1, 2]. Other solutions have been formulated asymptotically by using the physical argument that, in most situations not involving explosions, the pressure fluctuation in an acoustic signal is much smaller than the ambient pressure. Recall that linear acoustic theory is predicated on the assumption that the pressure fluctuation is infinitesimal.

Wave motions can be classified according to whether the propagation is dispersive or non-dispersive [3]. This property refers to the phase speed, which is the speed with which the information conveyed by the waves (e.g., pressure or density) propagates from one location to another. The phase speed is dependent on the frequency content in a dispersive wave, according to a dispersion relation. Thus, a wave containing several frequencies will distort as it propagates. This phenomenon of frequency dispersion also occurs in linear acoustic theory. The primary purpose of a nonlinear study for such waves is to determine the effect on the dispersion relation of the finite amplitude of the wave.

A non-dispersive wave in linear theory maintains its shape without distortion as it propagates because contributions to the wave that differ in frequency propagate with the same speed, by definition. Nevertheless, nonlinearity introduces distortion because the phase speed generally depends on the magnitude of the information being conveyed. This distortion is called amplitude dispersion.

Dispersive acoustic waves occur in various multidimensional situations. Some nonlinear results of this type are discussed later. However, non-dispersive waves have been more difficult to analyze. The primary purpose of this paper is to describe recent developments in evaluating nonlinear effects in non-dispersive waves, particularly as they pertain to multidimensional situations.

One basic approach in treating planar non-dispersive waves is to solve a series of first order differential equations – e.g., momentum and conservation of mass – using the method of characteristics. It is not the aim of this paper to survey this type of work; typical treatments of waves in bounded and infinite media are available [3-16].

The difficulty with the method of characteristics lies in its extension to multidimensional problems. A primary source of this difficulty, as has been noted [5], lies in the fact that the boundary conditions in a physically realistic problem are stated along physical coordinate lines, rather than along the characteristics. A lesser complication for multidimensional problems is the need to satisfy several differential equations simultaneously.

*School of Mechanical Engineering, Purdue University, West Lafayette, Indiana 47907

The method of geometrical acoustics [3, 17-22], which is closely related to the method of characteristics, has been successfully applied to several multidimensional systems. However, the results of such investigations are usually qualitative.

Another line of investigation for planar waves has been to solve a Burger's equation for the wave motion [23-33]; it is thus possible to account for viscosity and shocks. This approach has another asset in that only one differential equation must be solved. The difficulties with Burger's equation are that it treats only distortion phenomena that depend on one spatial variable and it is sometimes only an approximation of the true governing equations.

If attention is restricted to inviscid fluids, a formulation that leads to a single governing differential equation is one that makes use of a velocity potential function. Specifically, let the velocity of a fluid particle be

$$\underline{v} = \nabla\phi \tag{1}$$

where ∇ is the spatial gradient. When the phase speed (i.e., speed of sound) of an infinitesimal planar wave in a gas at ambient pressure p_0 is denoted as c_0, the potential function is found to obey

$$\frac{\partial^2\phi}{\partial t^2} - c_0^2\,\nabla^2\phi + (\gamma-1)\frac{\partial\phi}{\partial t}\nabla^2\phi + \frac{\partial}{\partial t}(\nabla\phi\cdot\nabla\phi)$$
$$+\frac{1}{2}(\gamma-1)\,\nabla^2\phi(\nabla\phi\cdot\nabla\phi) + \ldots = 0 \tag{2}$$

The gage pressure p can be derived from the potential function by solving

$$\int\frac{dp}{\rho} \equiv \frac{c_0^2}{(\gamma-1)}\left[(1+\frac{p}{p_0})^{(\gamma-1)/\gamma} - 1\right]$$
$$= -\frac{\partial\phi}{\partial t} - \frac{1}{2}\nabla\phi\cdot\nabla\phi \tag{3}$$

Equations (2) and (3) have been derived [34] for an ideal gas, with γ being the ratio of specific heats. However, these equations can also be applied to liquids by redefining γ [35]. The method whereby these basic equations can be solved for the wave motion in a variety of systems is the subject of this paper.

PLANAR WAVES

An exact solution for a planar wave propagating along the axis of a tube was obtained by Earnshaw; the derivation has been published [1, 2]. This solution has served as the test case in the development of the analytical method for solving other types of problems. The particle velocity v in a planar wave was found to propagate in space with a phase speed $c = c_0 + (\gamma + 1)v/2$. Therefore, the wave resulting from an arbitrary disturbance $\frac{v}{c_0} = F(t)$ at $x = 0$ will satisfy*

$$\frac{v}{c_0} = F(t - \frac{x}{c})$$
$$= F[t - \frac{x}{c_0}(1 + \frac{\gamma+1}{2}\frac{v}{c_0})^{-1}] \tag{4}$$

The dependence of phase speed on particle velocity is the nonlinear phenomenon of amplitude dispersion. In linear theory, where $v/c_0 \to 0$, the phase speed reduces to $c = c_0$; the shape of the wave is unmodified as the wave propagates through the fluid medium. Thus, the linear solution is non-dispersive. However, if v/c_0 is finite, the dependence of phase speed on v indicates that, at any instant, a phase containing positive or negative v will be advanced or retarded in space, respectively, relative to the linear counterpart. This discrepancy will grow with increasing distance, until a shock ($\partial v/\partial x = \infty$) forms. This is shown in Figure 1 for a harmonic disturbance: $F(t) = -0.02 \sin(\omega t)$. Beyond the location where the shock forms, the response predicted by equation (3) is multivalued. Weak shock theory [3, 36-40] – in which the Rankine-Hugoniot relations are used for

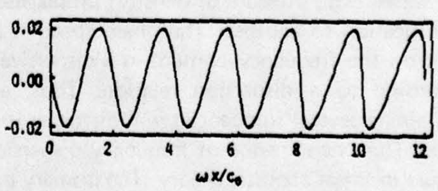

Figure 1. Earnshaw's Solution for a Planar Wave due to Harmonic Excitation

*The functional form given by Lamb [1] is slightly different because it corresponds to an initial value problem in which the velocity is specified as $v = F(x)$ when $t = 0$.

the propagation of discontinuous disturbances in a gas, can then be used to fit the shock into the regular solution for unshocked regions. Another method for treating shock is to extend the Fourier analysis of the Earnshaw solution [35, 41] into the region of discontinuity in order to remove the multi-valued portion of that solution [29].

In most systems of practical importance v/c_o, or equivalently p/p_o, is small. (This is even true for a sound pressure level of 150 dB in air.) Hence, it is necessary to solve equations (2) and (3) in situations in which ϕ is a finite but small quantity. If ϵ is a small parameter, $\epsilon << 1$, it is logical to expand ϕ in a perturbation series

$$\phi = \epsilon\phi_1 + \epsilon^2\phi_2 + \ldots \tag{5}$$

The result of substituting equation (5) into equation (2) is a sequence of linear partial differential equations for the ϕ_i.

In order to understand the consequence of such an expansion, suppose

$$\phi_1 = \frac{c_o}{\omega}\cos(\omega t - \frac{\omega x}{c_o}) \tag{6}$$

which corresponds to a harmonic excitation at $x = 0$ whose frequency is ω and whose velocity amplitude is ϵ. The resulting equation for ϕ_2 is then

$$\frac{\partial^2\phi_2}{\partial t^2} - c_o{}^2\frac{\partial^2\phi_2}{\partial x^2} = -\frac{1}{2}(\gamma + 1)\omega\sin(2\omega t - \frac{2\omega x}{c_o}) \tag{7}$$

The right side of equation (7) is not orthogonal to the homogeneous solution; the particular solution for ϕ_2 that is temporally periodic will thus contain a term that grows with increasing x. This, in turn, leads to a term in the expression for the particle velocity that is $0(\epsilon^2 x)$; the perturbation expansion is thus not uniformly accurate. Specifically, the size of the correction term ϕ_2 relative to the first term ϕ_1 is dependent on the location. Such a situation is unacceptable according to both the concepts of perturbation theory [42, 43], and the results of Earnshaw, equation (4).

A singular perturbation expansion is needed, in which both independent and dependent variables are modified. The initial analysis of this type for planar waves was performed in 1975 [44]; Lighthill's method [42, 43, 45] was used. The variable x was expanded in a series representing a coordinate straining transformation,

$$x = \alpha + \epsilon x_1(\alpha, t) + \ldots \tag{8}$$

Derivatives in the governing equation with respect to x were transformed to α derivatives, and the unknown function x_1 was determined by removing the nonhomogeneous term in equation (7). The particle velocity corresponding to the expansions for ϕ and x was found nevertheless to be nonuniformly accurate. This nonuniform accuracy necessitated a coordinate straining transformation of the variable α, in a form similar to equation (8). The unknown function in that expansion was determined by Pritulo's method of renormalization [43, 46], which seeks a function of the new variable whose Taylor series expansion in powers of ϵ matches the nonuniformly accurate expression.

It was subsequently demonstrated [47, 48] that the particle velocity can be determined directly by omitting Lighthill's method. Instead, the particular solution for ϕ_2 obtained from equation (7) was used to derive directly a nonuniformly accurate expression for v. The method of renormalization then yielded the correct uniformly accurate result.

It has also been pointed out [47] that the true potential function does indeed contain a growing term; an analysis that removes such terms is therefore conceptually in error. This matter has been discussed [49], and it was shown that the Taylor series in the renormalization procedure is valid only for small x. Thus, an additional criterion might be necessary to assure that the results of a renormalization solution are valid for large x. This criterion was postulated as a requirement that the expression for particle velocity have an implicit functional form, analogous to the exact solution shown in equation (4).

An analysis by the method of multiple scales of the planar wave problem has also been performed [47]. This approach, like those involving coordinate straining expansions, addresses situations in which a regular perturbation expansion is not uniformly accurate; e.g., the magnitude of the error depends on the coordinate x. A set of fast and slow variables, for example $x_1 = \epsilon^i x$, are defined and derivatives with

respect to x in the governing equations are replaced by partial derivatives with respect to the scaled variables x_i. Expressions for the dependent variables in terms of x_i are found by satisfying the criterion of uniform validity.

The multiple scales analysis [47] was performed by utilizing the characteristics, rather than the physical coordinates, as the independent variables. The correct functional dependence of the response could be obtained by considering the solution for the potential function, without proceeding to the consideration of the particle velocity and pressure. Nevertheless, it has not been proved that this virtue of the method of multiple scales is inherent to the method; it might be a consequence of formulating the problem in terms of the characteristics variables. Also, it might be that this result occurs only for planar waves that propagate without interacting with other waves.

THE BASIC METHOD

The analytical work and discussion arising from the application of basic perturbation techniques to the investigation of planar waves leads to the following direct method for formulating an analysis of small but finite-amplitude acoustic waves.

a. Expand the potential function in a perturbation series, and find the solution for each term that satisfies the perturbational form of the differential equation and boundary conditions. This step can be performed in conjunction with the method of renormalization, in which case the independent variables are unmodified at this step. Alternatively, the method of multiple scales can be employed, in which case the independent variable(s) determining the magnitude of the growing terms in the potential function is replaced by a set of fast and slow variables.

b. Derive expressions for the particle velocity and pressure, using the results for the potential function that are not uniformly accurate.

c. Render the expressions for particle velocity and pressure uniformly accurate. In the method of renormalization, a coordinate straining transformation analogous to equation (8) is required. In the method of multiple scales, it is necessary to solve partial differential equations involving the fast and slow variables.

The method of renormalization is easier to apply than the method of multiple scales because only algebraic manipulations are required to satisfy the criterion of uniform accuracy. However, the method of renormalization has a more limited range of validity, particularly with regard to dissipative effects [50]. It follows that, if it is not possible to evaluate a suitable coordinate straining transformation, it might be appropriate to reformulate the analysis in terms of the method of multiple scales.

The foregoing does not address the question of whether or not the resulting perturbation equations can be solved. Thus, it is improbable that a nonlinear analysis of a system will be any more successful than an analysis of the corresponding linearized system. A number of multidimensional systems that have already been investigated by these methods are discussed in Part II.

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LITERATURE REVIEW

survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

This issue of the DIGEST contains review articles on the behavior of elastomeric materials under dynamic loads and approximate techniques for plastic deformation of structures under impulsive loading.

Mr. E.C. Hobaica of General Dynamics Corporation has concluded his article on the behavior of elastomeric materials under dynamic loads. This review describes the properties of rubber and other elastomers when they are subjected to small amplitude sinusoidal stresses. Testing methods and data on dynamic properties are given.

Mr. W.E. Baker of the Southwest Research Institute has concluded his article on approximate techniques for plastic deformation of structures under impulsive loading. Research-oriented methods and design-oriented methods are described.

BEHAVIOR OF ELASTOMERIC MATERIALS UNDER DYNAMIC LOADS - II

E.C. Hobaica*

Abstract - This review describes the properties of rubber and other elastomers when they are subjected to small amplitude sinusoidal stresses. Testing methods and data on dynamic properties are given.

Elastomeric materials play a significant role in the practical design of many structures and components. The response of an elastomer to an imposed force is characterized by a displacement dependent on stress and rate of loading. All polymers show this time-dependent response to stress; but the response is most important and complex in polymers exhibiting elastomeric characteristics.

This is the second review of the state of the art of rubber when it is subjected to small amplitude, sinusoidal stresses. It attempts to cover the literature since 1976, when polymer theory affecting dynamic response of an elastomer, the temperature frequency equivalence, methods used in dynamic testing, and general polymer and formulation effects were described [1]. This review summarizes the literature since 1975 and attempts to bring the reader up-to-date on recent publications. Some data generated at Electric Boat in past years are presented. A few papers missed in the first review are referenced.

Papers of general interest [2-5] contain procedures for determining stiffness and damping properties of elastomers. In one case [4] a forced vibration resonant mass type of apparatus and polybutadiene were used. The effects of temperature, dissipation level, and geometry on the dynamic behavior were investigated. The work and subsequent conclusions are detailed; extensive data are given on stiffness and damping at frequencies up to 1,500 Hz. A rotating unbalance in a rotor running to 60,000 RPM has been used [5]. Elastomeric elements supported a resonant mass, and dynamic properties of the rubber materials were determined from acceleration measurements.

TESTING METHODS

A number of papers relating to testing have appeared [6-9]. Sutherland [6] described two experimental procedures conducted on an RTV rubber. In one case, wave propagation measurements of a 1,000 kHz pulse through cylindrical specimens over temperature ranges of 30°C to 60°C were run and data compiled. These data were used to determine the zero-strain slope of the instantaneous and equilibrium stress-strain curves for the RTV. The remainder of the stress-strain curve was determined in flyer-plate impact experiments, in which the high-amplitude stress-wave response of the material was determined. From these experiments, stress-strain curves of both the instantaneous and equilibrium responses were plotted. The curves are identical up to a strain of about 0.05 and then begin to diverge.

The paper by Dieterich [7] describes the viscosuperb computer program. A parabolic isoparametric solid finite element is used to predict static and dynamic (amplitude, phase angle, dynamic stiffness) characteristics of viscoelastic components.

A torsional pendulum based upon ASTM D-2236 was designed and built at the General Electric Laboratories [8]. It was used as a nondestructive, quality control device for certain polyester elastomers. The results of acceptance testing of two elastomers are given. The torsional pendulum imposes an angular displacement on a sample; shear modulus is determined from the decay rates of the oscillation. Frequencies between 1 and 10 Hz are generally possible with this apparatus.

Another commercial instrument not mentioned in the previous review is a viscoelasticimeter produced in France [9]. It measures force and displacement across a sample and phase difference at frequencies

**Principal Engineer, Electric Boat Division, General Dynamics Corporation, Eastern Point Road, Groton, CT 06340*

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to 1,000 Hz and over a temperature range of - 70°C to 130°C.

Lee [1] tested several elastomers including butadiene, nitrile, and polysulfide compounds on a torsional pendulum. The logarithmic decrement and shear modulus were determined as functions of temperature. The WLF shift was used to present the two above properties of the rubber as functions of frequency (1 to 100 kHz). Because the torsional pendulum operates at about 1 Hz, however, such an extrapolation must be made with caution.

DYNAMIC PROPERTIES

Investigations of the dynamic properties of various polymers are reviewed in this section. Dynamic properties of an ethylene/acrylic elastomer at temperatures to 160°C were measured [11]. Excellent stability of the dynamic properties was noted to 150°C.

Effects of primary molecular weight, molecular weight distribution, long-chain branch content, and branching pattern on dynamic viscoelastic properties of polybutadiene networks were studied [12]. Frequencies from 1 Hz to 110 Hz were used. Pure gum vulcanizates, compounds with diluents, and carbon black-filled compounds were compared.

In later work, the dynamic modulus of styrene-diene block copolymers was examined at 35 Hz using a Rheovibron. A plateau was noted in the dynamic storage modulus; methods were developed for estimating height as well as the effect of a center-block compatible diluent. This work has added to the understanding of the behavior of pressure-sensitive adhesives.

A number of compounding parameters of chloroprene rubber have been investigated for their effects on the dynamic behavior of the polymer [14]. Higher carbon black and plasticizer loading caused a significant increase in dynamic damping properties.

Dynamic properties of natural rubber tire stocks with varying carbon black and sulfur contents were measured using an MTS High Rate Testing Apparatus [15]. Increased dynamic testing of tire stocks was recommended.

The increasing temperature and energy absorption requirements that have been imposed on automotive mounts in recent years have generated tests of bromobutyl blends of natural rubber, ethylene-propylene rubber (EPBM), and polypropylene oxide (PPO) [16]. The Goodrich Flexometer and the Rheovibron tester were used to determine dynamic modulus and loss factors over a range of frequencies. Formulation and recommendations were made for specific requirements.

The expanding use of EPDM elastomers in the automotive field have been described [17]. Their role in energy absorption is discussed. A description of the chemistry, structure, properties, and compounding of a polynorbornene (PNR) polymer has been published [18]. This thermoplastic has a low melting point and can be compounded into an elastomer by adding suitable processing oils. Some data on damping factors of this polymer are compared to natural rubber and chlorobutyl at 125 Hz.

Another study was related to the effects of carbon black on the viscoelastic properties of rubber [19]. In this case, natural rubber vulcanizates of various cross-linked densities were examined for variations in tensile stress relaxation properties. A relationship between stress relaxation, loss factor, and strain amplitude was presented.

Medalia and a co-worker have continued to work in the area of carbon black and its effects on rubber properties [20, 21]. Carbon black surface and morphology were studied for their effects on the hysteresis of NR and IIR rubbers [20]. A general review of the role of carbon black on dynamic properties of rubber contains extensive references [21].

The problem of compatibility of various rubber polymers and the properties of their blends have been subjects of numerous studies through the years. Dynamic mecahnical properties have been used over a range of temperatures to determine the compatibility of a number of polymer blends [22]. Included were blends of polybutadiene, natural rubber, and chlorobutyl. A Rheovibron was used to determine dynamic properties from - 100°C to 20°C. Temperature dependence of the loss factor was shown for a number of 50/50 blends; changes in these spectra occurred with more complete vulcanization.

Polysulfide polymers have been examined as rubber modifiers [23]. Vulcanization, temperature, and static property changes of natural rubber and SBR rubber compounds modified with polysulfide were described. Tests on these compounds using the Goodrich Flexometer and Monsanto Fatigue Tester reduced heat build-up, indicating a reduction of the loss factor for these materials.

A theory has been developed [24] to explain the rapid changes in modulus of filled polymers close to the glass transition temperature. Experiments were run with a glass bead-filled nitrile rubber on the torsional pendulum. The modulus was greatly affected by the particle-particle contacts and the degree of agglomeration.

Jones [25] presented a reduced-temperature nomograph that allows data on modulus and loss factors of viscoelastic materials to be obtained as a function of both frequency and temperature from the same graph. Use of the techniques described greatly simplify the handling and presentation of data.

The effects of temperature, molecular weight, and molecular weight distribution on the viscoelastic properties of polyisobutylene melts have been determined. In one case a Weissenberg rheogonimeter was used to develop data on viscosity vs frequency over a temperature range of 50° to 242° C [26].

Dynamic properties of a series of polyurethane elastomers have been studied as a function of curative system, curative level, catalyst level, and curing temperature [27]. A Rheovibron was used at 110 Hz as well as a Goodrich Flexometer. Good correlation was noted between the heat build-up of the latter device and the loss modulus data determined on the Rheovibron.

The synthesis of some EPDM and polyisobutylene bigraft copolymers have been described [28]. Dynamic data based on the Rheovibron viscometer were used to examine the phase composition of these bigrafts.

Dynamic modulus and loss factor data on natural rubber have been included in a design manual for elastomeric bearings [29].

Through the years, an extensive body of data on dynamic properties of various rubber materials has been accumulated by the Electric Boat Division of General Dynamics Corporation. Most of the data were obtained from the Rheovibron Tester at four frequencies – 3.5 Hz, 11 Hz, 35 Hz, and 110 Hz – with temperatures as low as −40°F. The time-temperature super position techniques previously described [1] have been used to extrapolate the values at the low frequencies upward by two decades. Figures 1 through 5 show some of these data. The loss factor can be determined from these curves by the ratio of loss modulus and rear modulus. The data illustrate the broad variability in dynamic modulus and loss factors with frequency and temperature changes. A designer must recognize this variability when he considers dynamic effects on elastomers.

The highest loss factors obtained were with butyl and nitrile compounds; the lowest were with polybutadiene and EPDM. The small temperature sensitivity of EPDM and polybutadiene at 0°C and 20°C is shown in Figures 3 and 4. These polymers are still behaving as rubbery materials, and the changes in modulus with frequency are still rather shallow. Contrast this with the butyl, neoprene, and nitrile polymers, in which the changes in modulus occur more rapidly as frequency and temperature change. We obviously are higher in the transition zone between rubbery and glassy behaviors. The nitrile rubber is very close to the glassy region at 0°C.

Other data were gathered on a flexure wave apparatus similar to that described by Holtz and Cramer [30]. This equipment can give direct measurement of Young's Modulus (real and imaginary) and the loss factor at frequencies sometimes above 20 kHz. The complex modulus and loss factor are plotted vs frequency at three different temperatures for two different rubber materials (Figures 6 and 7). Again, note the contrast in results between a nitrile composition and a less temperature sensitive butyl compound. The butyl compounds contains a very small number of voids that are incorporated during the molding operation.

ACKNOWLEDGEMENT

A number of people have been involved at Electric Boat through the years in dynamic testing. Two, in particular, who should be thanked for the data appearing in this article are E.F. Kerttula and J.A. McDonald.

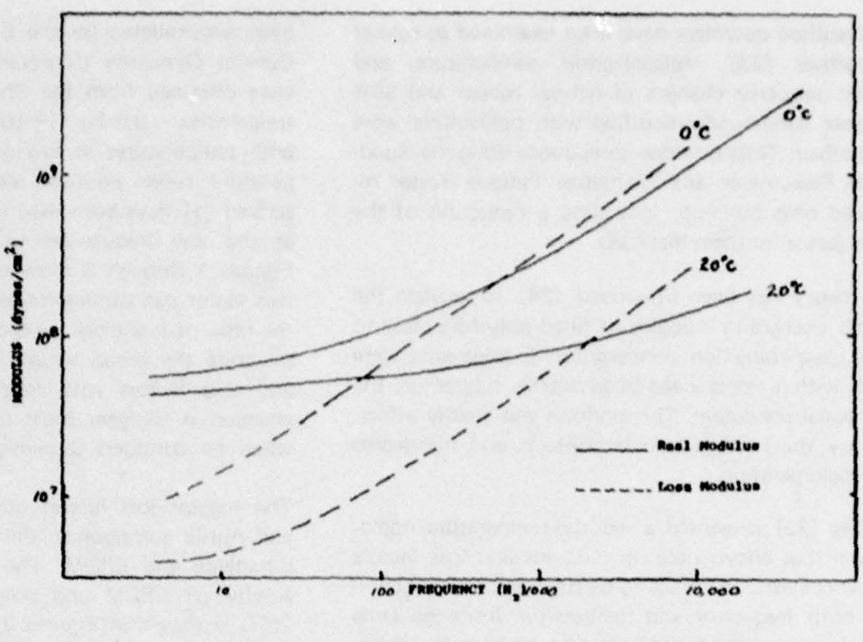

Figure 1. Modulus vs. Frequency for Neoprene Rubber (WRT/WD - 50A)

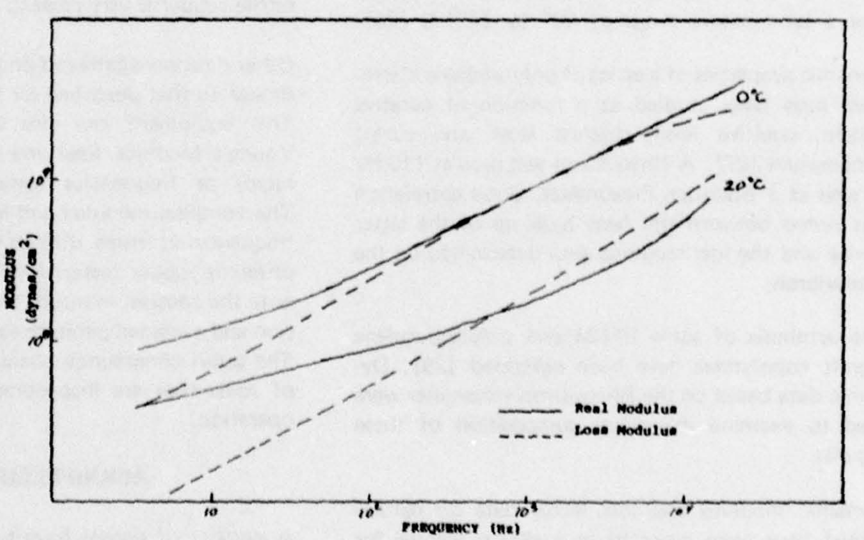

Figure 2. Modulus vs. Frequency for Butyl Compound at Two Temperatures

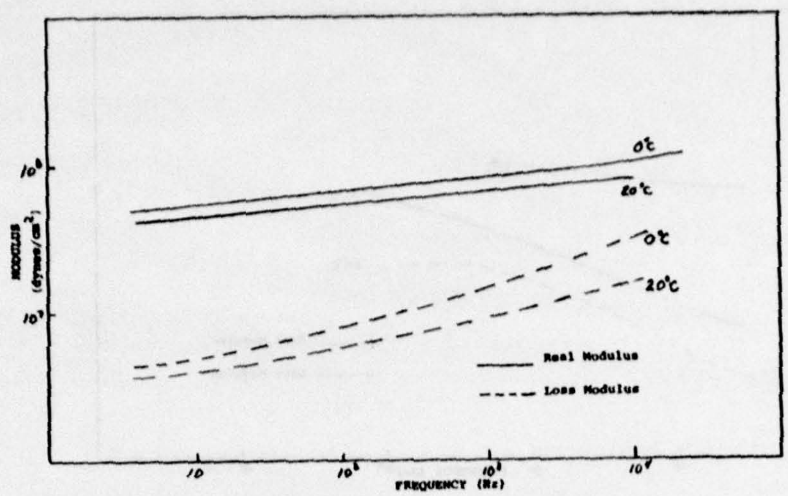

Figure 3. Modulus vs. Frequency for EPDM Compound (51A) at Two Temperatures

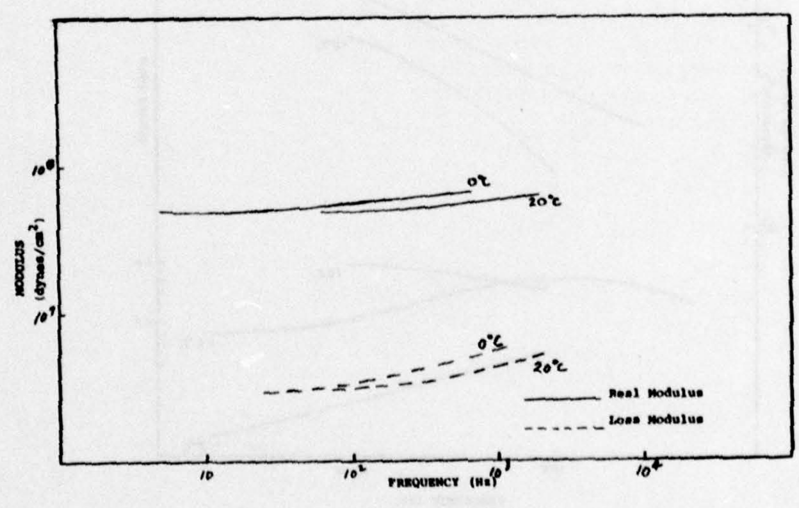

Figure 4. Modulus vs. Frequency for Polybutadiene Compound (53A) at Two Temperatures

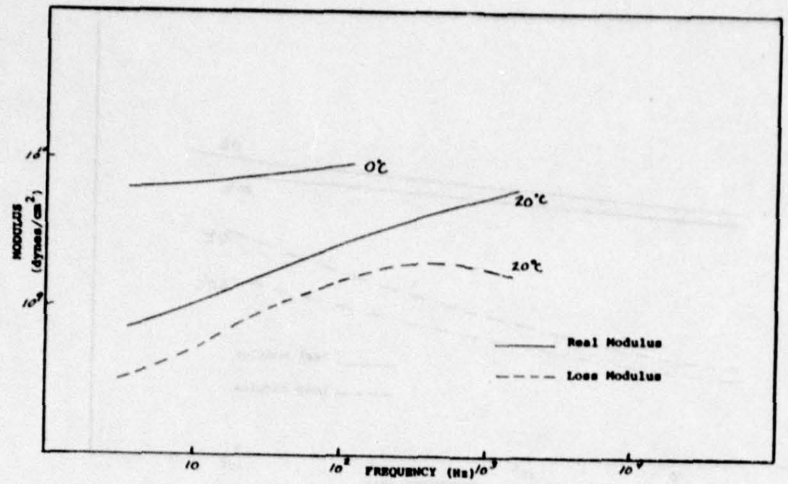

Figure 5. Modulus vs. Frequency for Nitrile Rubber (47% Acrylonitrile - 90A) at Two Temperatures

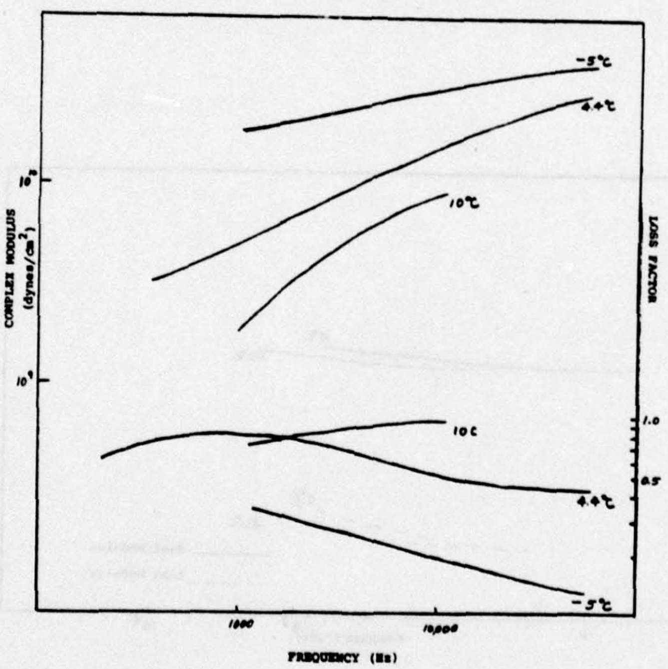

Figure 6. Complex Modulus and Loss Factor vs. Frequency for Nitrile Rubber (69A) at Three Temperatures

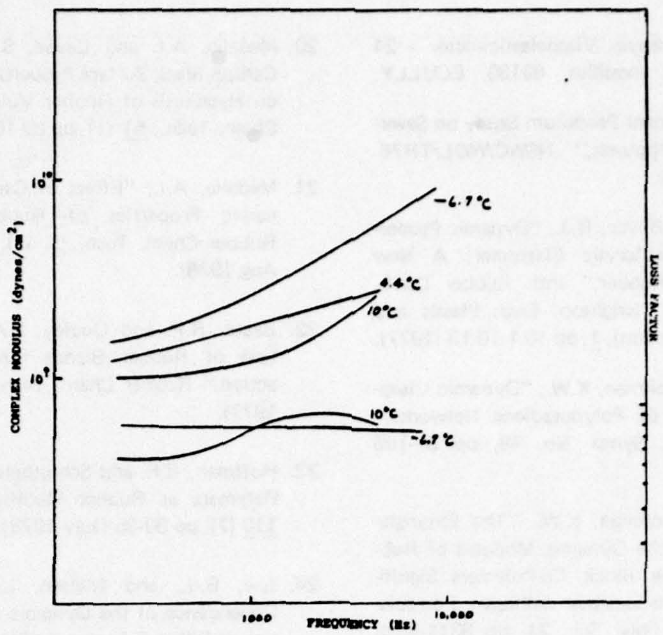

Figure 7. Complex Modulus and Loss Factor vs. Frequency for Porous Butyl Material at Three Temperatures

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APPROXIMATE TECHNIQUES FOR PLASTIC DEFORMATION OF STRUCTURES UNDER IMPULSIVE LOADING, II

W.E. Baker*

***Abstract** - Recent work on approximate techniques for plastic deformation of structures under impulsive loading is summarized. Research-oriented methods and design-oriented methods are described. Several design-oriented methods have been utilized by structural designers.*

This review is an update of a 1975 review [1]. References and discussion from the previous review are not repeated; rather, later work on the topic is summarized. Older work on a related topic not previously covered -- that is, design-oriented analyses of plastic response of structures to impulsive loading -- has been added. As before, discussion of complex analytic methods requiring the use of large computer programs has been avoided because these methods cannot be classed as approximate techniques.

Approximate analytic methods for plastic structural response under impulsive loading are either research-oriented or design-oriented. Research-oriented methods are limited to such relatively simple structural geometries as rectangular or circular plates of uniform thickness, beams or rings of uniform rectangular cross section, and spherical or cylindrical shells of uniform thickness. Simple structures analyzed in research-oriented papers are usually of homogeneous materials; e.g., steel or aluminum alloy. The advantages of such limitations are that basic principles (e.g., limit theorems) can be emphasized, corroboration by laboratory-scale experiments is possible and relatively inexpensive, and basic research funding can be obtained to support the work. The primary disadvantage is lack of direct applicability to real structures.

Design-oriented approximate analytic methods are aimed at predicting the response of real structures or elements of real structures. Cross sections of beams can be a variety of commercially available structural shapes -- channels, I-beams, or box sections. Plates can be corrugated or formed from thin, flat materials. Various built-up sections can be assumed. Not only can such homogeneous materials as structural steel be treated but also such composite materials as reinforced concrete. Disadvantages of the design-oriented approximate methods for the more complex real structures lie in greater departure from physical reality than for the simpler idealized structures, added complexity and expense of testing to verify the methods, and difficulty in obtaining support funding to verify the methods. But, despite these disadvantages, several design-oriented approximate techniques have been well accepted by the structural design community.

RESEARCH-ORIENTED ANALYSES

Two reviews [2, 3] cover the broad topic of dynamic plastic behavior of structures and include discussions of papers on impulse-sensitive simple structures.

More specific research-oriented analyses have been made within the past few years for a variety of simple structural elements. Increasingly, either a simple rule for rate-sensitivity of the structural materials is included, upper and lower bounds for structural deformation are predicted, large deformations are predicted, or some combination of these refinements to simple rigid-plastic, small deformation theory is made [4-15]. Typical effects of considering large deflections versus linear, small-deflection theory are shown in Figure 1. The dimensionless maximum deformation of a uniformly-impulsed beam is given as a function of dimensionless initial kinetic energy; the figure indicates the marked deviation from linear theory for deformations exceeding twice the beam thickness.

*Institute Scientist, Southwest Research Institute, P.O. Box 28510, San Antonio, TX 78284

machinery and power-driven structures. The work- Objective: The seminar will cover various means for

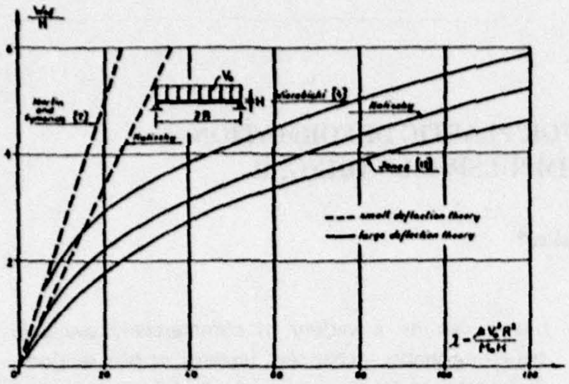

Figure 1. Influence of Geometry Changes on Impulsive Response of Beams [12]

DESIGN-ORIENTED ANALYSES

Design-oriented approximate analyses fall generally into two categories. The first includes computations in which the complex structure is approximated as a single-degree-of-freedom system with an elastic-plastic resistance function; the response is computed by relatively simple computer programs for various transient loading functions. The resulting predictions of maximum deformation or plastic strain are reduced to design curves and graphs. The author calls this method Biggs' Method, because of the clear and cogent presentation by J.M. Biggs [16]. It is also called Newmark's Method, after N. Newmark, and was apparently initially developed more or less independently by these two men. The technique has been incorporated into several handbooks [17-21] that are widely used by architect-engineers in dynamic design or for evaluation of blast-resistant structures. A typical set of design curves is shown in Figure 2.

The second category of design-oriented approximate analyses involves the use of energy balances between initial work done by dynamic pressures or impacts and plastic strain energy absorbed by the deformed structure. These methods are often used in conjunction with the pressure-impulse (P-I) concept. Both classes of approximation have been discussed [1]; only later papers or recently available papers are given here.

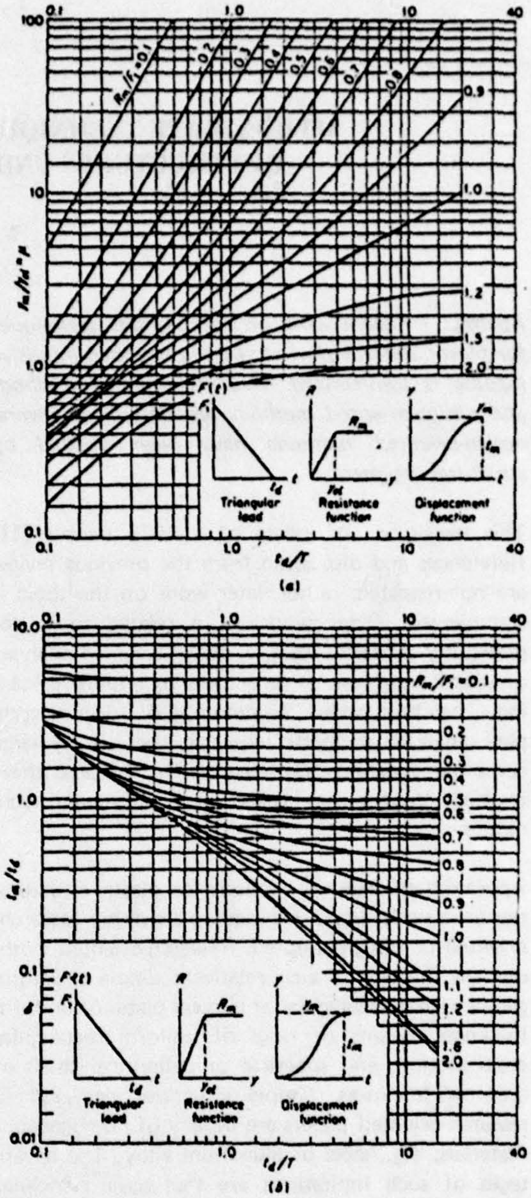

Figure 2. Maximum Response of Elastic-Plastic One-dof System for a Triangular Load (U.S. Army Corps of Engineers, 1957)

The earliest application of the P-I concept in assessing structural damage was, in the author's opinion, a now declassified report [22]. Empirical data on external blast damage from explosive detonations near a specific aircraft were correlated with combina-

tions of air-blast pressure and impulse. The data roughly described rectangular hyperbolas in a graph of P versus I. These isodamage curves were assumed to be basic characteristics of the complex structure and were used to predict variations in aircraft damage for altitude ambient conditions from sea level test data. Revised plots of blast pressures and impulses that would occur for explosions at various altitudes were laid over the P-I diagrams. A good review [23] on the use of the P-I concept has recently appeared; the effect of pulse shape on response of simple elastic-plastic or rigid-plastic structures is discussed and has been amplified in later work [21]. Figure 3 is representative of that work.

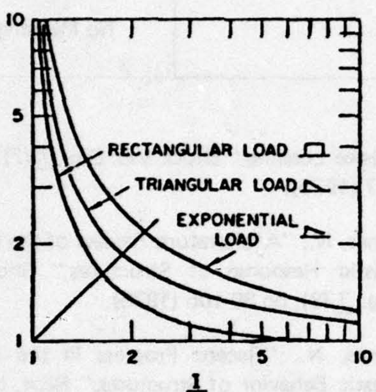

Figure 3. Critical Load Curves for the Simple Rigid-Plastic System [23]

A number of recent papers [24-28] give specific applications of either the P-I concept, energy methods, or both; the methods are used to develop dynamic plastic structural design equations or graphs. A number of results are included in other work [21]. New developments include use of single-function constitutive relations to approximate elastic-plastic behavior and energy solutions for two-degree-of-freedom systems. Energy methods and reflected blast wave data have been used to predict failure thresholds for heavily reinforced concrete walls after nearby explosions [28]. One of the prediction curves for concrete wall deflection under impulsive air blast loading is shown in Figure 4.

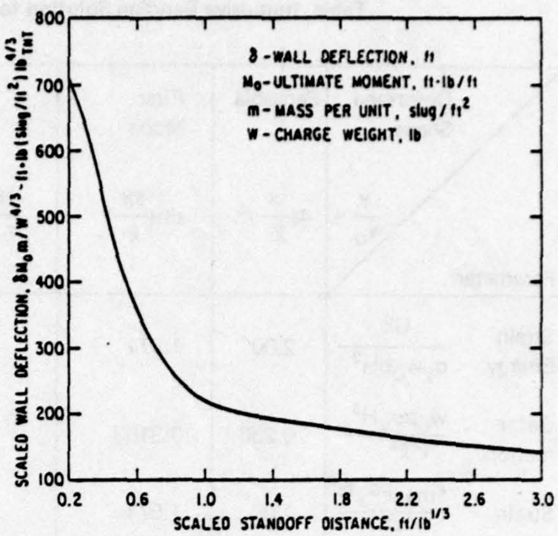

Figure 4. Scaled Deflection of Concrete Wall Due to Impulsive Air Blast Loading [28]

EXPERIMENTS

A number of the impulsive response analyses cited here have been corroborated by test data. The most popular ways of applying impulsive loads to simple or laboratory-scale structures are to load with commercial sheet explosive or to impact with deformable projectiles. Test data of this type have been published [7, 10, 14, 15, 29, 30]. For more complex structures, air-blast loading from high explosives detonated nearby is more often used as the loading source. Test data of this kind have also been reported [19, 20, 22-24, 27]. In some instances, the latter tests are carefully instrumented proof tests of blast-resistant structures; pressures, strains, and displacements are recorded. Comparisons of such test data for a complex structure using various methods of dynamic analysis have appeared [19, 27].

CLOSURE

This discussion has been separated into research-oriented and design-oriented analyses. Indeed, the approaches appear to have been developed separately. But they have much in common and employ similar assumptions under different guises or names. The mode approximation assumptions from the Brown

Table. Impulsive Bending Solution for Simply-Supported Plastic Beam [21]

Parameter \ Deformed Shape		Parabola	First Mode	Static Deformed Shape	Stationary Hinge
	$\frac{y}{w_o} =$	$4(\frac{x}{\ell})^2$	$\sin(\frac{\pi x}{\ell})$	$\frac{16}{5}[(\frac{x}{\ell}) - 2(\frac{x}{\ell})^3 + (\frac{x}{\ell})^4]$	$2(\frac{x}{\ell})$ for $0 \leq \frac{x}{\ell} \leq ½$
Strain Energy	$\frac{U\ell}{\sigma_y w_o b H^2}$	2.00	1.571	1.60	1.00
Deformation	$\frac{w_o \rho \sigma_y H^3}{i^2 \ell^2}$	0.250	0.3183	0.3125	0.500
Strain	$\frac{\epsilon_{max} \rho \sigma_y H^2}{i^2}$	1.00	1.571	1.500	No Meaning

University school do not basically differ from the simplifying assumptions made by Biggs and Newmark to reduce a complex structure to an equivalent system with one degree of freedom. Similarly, the necessity to assume a deformed shape for a structure in the energy balance methods is equivalent to the mode approximation. This point has been discussed at some length [21].

The Table shows the influence of drastic differences in mode shape. Four deformed shapes are assumed for an impulsively-loaded beam; multipliers for dimensionless strain energy, maximum deflection, and maximum strain are shown. It can be seen that strain energies and deformations can differ by a factor of two; maximum strain can be more sensitive -- even to having no meaning for the assumption of a single concentrated hinge.

In conclusion, the author feels that considerable excellent work has been done since 1975 and that he has cited a representative sample of this work. However, no landmark papers have appeared that open new avenues of approach.

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BOOK REVIEWS

VIBRATION ENGINEERING

A.D. Dimarogonas
West Publishing Co., 1976

This is an introductory to intermediate level text on vibration analysis. Starting from geometry and kinematics of vibration, the book covers the traditional single-degree-of-freedom systems (Chapters 2, 3, and 5). The vibration of continua is covered in Chapter 7. Multiple-degree-of-freedom lumped mass systems are covered in Chapters 8 and 9. These topics represent the standard treatment of vibration of linear systems, and, for most part, the presentations are excellent. However, more attention should be given to the eigenvalue problem and modal analysis, in view of the importance of these two topics in practical vibration analysis. Also missing are the modern direct intergration methods (e.g., Newmark, Houbolt, Wilson) for direct solution of forced vibration problems.

Computer-aided vibration analysis is the subject of Chapter 6; Chapter 10 includes some special methods for computer-aided vibration analysis. Most of the information in Chapter 6 is related to FORTRAN programming, a subject hardly suitable for a vibration book. Furthermore, most practicing vibration engineers are interested in using computer programs to solve specific problems, rather than in developing programs. It would thus have been more productive if Chapter 6 emphasized the use of available computer programs for vibration analysis. Among the special methods mentioned in Chapter 10 are the Rayleigh, Rayleigh-Ritz (the author uses the term method of constraints), transfer matrix, and finite element. The coverage of finite elements even very briefly is a healthy trend because most practical vibration analyses are now handled by finite element computer programs. It would be beneficial to the reader if a more general treatment of the finite element method -- at least a brief mention of the formulation of plate elements -- were presented, and if the reader were informed that general purpose programs exist that use finite element formulations.

Among the special features of the book are the treatment of stability and nonlinear system in Chapters 4 and 12, vibration of rotating shafts in Chapter 11, the effect of vibration in man and machines in Chapter 13, and vibration synthesis and identification in Chapter 14. Stability analysis includes an introduction of the methods of Liapunov, which is not seen in most other vibration books. The brief introduction of vibrational effects is interesting, especially in today's ecology-conscious society. The Chapter on synthesis and identification is unique among vibration books, even though it is very brief it calls attention to the important problem of identification of models from test data. This new field should be given more attention in future books in vibration.

In summary, with proper supplemental material from the instructor, this book could be used as an introductory text in vibration analysis. The book contains more than 110 solved examples, and thus can also be used as a reference for practicing engineers.

B.P. Wang
Sperry Marine Systems
Sperry Rand Corporation
Charlottesville, VA 22901

WAVE PROPAGATION IN ELASTIC SOLIDS

J.D. Achenbach
North-Holland Publishing Co., Amsterdam, 1975

Professor Achenbach, a member of the Civil Engineering Department at Northwestern University, is an internationally known expert in fracture mechanics and the dynamics of composite media. He is eminently well qualified to write a text on elastic wave propagation.

The book is a welcome addition to the literature in that it makes readily accessible many of the developments in the field of the last 20 years or so. The text is primarily concerned with theoretical aspects and is directed toward graduate students. The prospective reader should have had a first course in elasticity and be reasonably familiar with Fourier series, complex variables, and integral transform techniques. The text is organized into ten chapters.

Chapter one departs from the traditional in that it begins with a thorough discussion of the Eulerian and Lagrangian methods of description; by this means conditions are established for which the process of linearization is valid. General solutions to the one-dimensional wave equation are then developed, as well as such concepts as mechanical impedance, reflection, and transmission coefficients and dispersion, power, and velocity of energy propagation. Fourier series and integrals are introduced at an elementary level.

Chapter two is devoted to further developing the general background. It begins with a review of the indicial notation and vector analysis. The stress equations of motion are derived; the linear elastic solid, with emphasis on the isotropic case, is introduced. Initial-boundary value problems are elaborated, with one- and two-dimensional examples being cited. Power and energy-concepts are further extended, and Hamilton's principle is derived from the stress equations of motion. Displacement potentials are then introduced, which leads naturally to discussion of vector relationships in orthogonal curvilinear coordinates.

The opening sections of Chapter three involve proofs for a uniqueness theorem, the Betti-Rayleigh reciprocity theorem, the completeness of the potential representation of the displacement field, and the Helmholtz decomposition theorem. A succinct treatment of waves generated by body forces includes the use of delta functions in point and line singularities for the scalar wave equation; such fundamental differences as the persistence of the two-dimensional signal are pointed out. Similar results are given for the elastodynamic case, and a Kirchhoff-type integral representation is developed. The chapter concludes with a discussion of the difficulty of constructing Green's functions and a treatment of the special case of harmonic time dependency.

Waves in unbounded media are the topic of Chapter four. It begins with an examination of plane waves, including nonhomogeneous ones. Superposition methods are used to obtain a general solution for a spherical cavity loaded by a radially symmetric boundary pressure with an arbitrary time dependence. Two-dimensional motions with axial symmetry are briefly reviewed. Subsequent sections are concerned with the propgation of surfaces of discontinuity; rays; wave-front expansions; and the theory, and some applications, of characteristics. These sections are a strong feature of the book because this valuable material is frequently omitted in many standard texts. The closing sections involve another welcome feature -- namely a discussion of homogeneous solutions of the wave equation and their application to shear wave propagation in a wedge.

Harmonic wave propagation in half spaces is covered in Chapter five. Considerable detail, including interpretations involving slowness diagrams, is given on the reflection and transmission of plane waves at plane interfaces. Surface wave propagation is analyzed, a somewhat novel feature being the use of the argument principle of complex variable theory to assess the number of roots of the Rayleigh function in the physical plane. The concluding section contains a treatment of Stoneley waves.

Harmonic propagation in waveguides is taken up in Chapter six. Considerable detail is given on dispersion relations for SH, longitudinal, and flexural wave propagation in an infinite plate; Love wave propagation; and torsional, longitudinal, and flexural waves in an infinite circular rod. Included is a treatment, using Hamilton's principle, of the relationship between group velocity and the velocity of energy transportation. The chapter closes with a brief account of elementary approximate theories -- as well as theories of the Timoshenko type -- for transients in rods and plates.

Chapter seven treats transient motions in half space. It will probably make the heaviest mathematical demands of the neophyte: in the space of 20 pages or so are included Fourier, Laplace, and Hankel transforms, and the asymptotic evaluation of integrals using stationary phase and saddle point methods. The first application involves shear wave propagation; the classic Lamb problem of excitation

by a surface normal line load is analyzed using the Cagniard-de Hoop technique. I suspect some readers will experience trouble here because the author assumes considerable expertise in multi-valued function theory, a subject that is at best covered only briefly in many introductory courses on complex variables. The surface point load problem is studied using Hankel transforms. The approach is one in which the Cagniard-de Hoop idea is harnessed by replacing Bessel function with suitable integral representations.

Transients in infinite rods and plates are taken up in Chapter eight by means of multi-integral transform methods. The treatment is rather brief, with the relevant literature being cited for most of the detail.

Chapter nine introduces wave diffraction. Although only plane waves and semi-infinite scatterers are described, the material considerably enhances the value of the book because diffraction is completely omitted in many standard works. Some prior exposure to integral equations would be beneficial to the reader. The major thrust is an explanation of the Wiener-Hopf technique; the general factorization procedure is illustrated for the Rayleigh function. The diffraction of SH waves by a semi-infinite slit is covered in detail. The corresponding problem for an incident longitudinal wave is briefly discussed.

The final chapter is ambitious in that it touches on the effects of temperature, viscoelasticity, anisotropy, and nonlinearities. It opens with a short development of a theory of coupled thermoelasticity, which is then used to study the propagation of harmonic plane waves in infinite media. Important results, such as the lack of coupling between transverse waves and temperature and the attenuation and dispersion of mechanical waves, are highlighted. Linear viscoelasticity is examined; such concepts as hereditary integrals, creep and relaxation functions, and complex moduli are introduced. The main effects on harmonic and transient wave propagation are pointed out. The sections on anisotropy are brief, but the interested reader is steered to the relevant literature. The possibility of shock wave formation in solids is illustrated using a one-dimensional model in which a nonlinear relationship exists between stress and deformation gradient.

Two final items are worthy of mention. The addition of problems at the end of each chapter will be an attractive feature to many instructors. North Holland are to be congratulated on bringing out a paperback edition considering the average student's (and Professor's) budget!

R.A. Scott
Professor of Applied Mechanics and
Engineering Science
University of Michigan
Ann Arbor, MI 48109

HANDBOOK OF INDUSTRIAL NOISE CONTROL

L.L. Faulkner, Editor
Industrial Press, Edison, NJ, 1976

This book is a practical volume for the engineer interested in maintenance and the engineering designer requiring design hints in cook book form. It is easy to read, easy to understand, and full of information. Few of the many volumes written on this subject are equal to this book.

The 12 chapters were written by eminent authorities; an appendix contains SI conversions. Chapters I and II explain the fundamentals of sound and include definitions of sound pressure levels, acoustic impedance, decibels, absorption coefficients, sound transmission through panels, and response of the human ear. An excellent glossary of terms used in sound and vibration is included. Various types of microphones and associated electronic equipment are described; the proper placement of the former for meaningful results is given. Differences in the A, B, C, and D scales are explained and serve as a good introduction to understanding noise and its measurement.

Chapters III and IV describe standards of noise control required for various commercial and industrial equipment, with particular reference to the initiating source. The interpretation of noise measurements, calculation of sound pressure levels and their relationship to OSHA requirements are considered with regard to machinery noise. OSHA requirements and criteria are explained in simple language and include

annoyance criteria, loudness levels, and noise criteria curves. Community noise criteria outdoors are given. Three examples are worked out and explained.

In Chapter V acoustic materials required for noise control are described. Acoustic absorption and transmission loss attributable to materials and their roles in noise control are given as are suggestions for sound barrier systems (walls) and proper methods for measuring sound absorption. A sound transmission rating system is considered, and its relationship to sound control is explained. Systems are illustrated and details of their use in rooms and other enclosures are given.

Chapter VI describes external dynamic loads and loads resulting from and occurring within machines and structures and the special damping materials required. Sonic fatigue of aircraft skins and resonance of jet engine fans and turbine blades also sometimes require special damping materials. The damping behavior of materials is described and applied to viscoelastic materials, vitreous enamels, and honeycomb structures. The response of damped structures is explained, and the application of damping materials to metallic structures is described. Examples are given and applied to structures.

Chapter VII introduces vibration theory and describes vibration isolation. Various oscillators -- pneumatic, rubber, steel spring -- are considered. Reduction of harmful effects of vibration and the proper use of vibration absorbers are described. Shock response and excitation are considered, as are ways for reducing their devastating effects. Reduction of vibratory effects in machines are considered, as are ways for reducing the magnitude of excitation. The exciting forces of examples are given, along with design hints for reducing both noise and vibratory forces.

Chapter VIII has to do with reduction of machine noise from gears, bearings, and cams in the machine design process. The author describes in detail the reduction of noise. The chapter includes noise control of chain drives and slider mechanisms.

Fan and flow are noise sources. Measurements of fan noise are explained in Chapter IX, as are means for reduction. The author has provided an understandable explanation of air flow noise. Valve noise is briefly mentioned. Well explained examples are included.

Chapter X describes combustion noise which usually consists of high frequency screeches and low frequency pulsations. It is harmful to jet engines, fuel oil combustors, and furnaces. The author explains the origin of combustion noise, as well as ways for suppressing combustion driven oscillation.

Chapter XI is concerned with valve noise phenomena and the mechanism by which the latest type of valves has reduced noise and increased valve efficiency. Valves produce noise aerodynamically. Calculations are required for proper valve application. The author is well versed in this field and shows the calculations required to predict such noise. Hydrodynamic noise and ways for calculating it are considered, as are ways for reducing structural damage. The acoustic cut-off frequency, coincident frequency, and ring frequencies of pipes are described, but the chapter would have been more complete if the overall effect of pipes acting as shells had been considered. The latter becomes important if fluid velocity is in resonance with the pipes.

The concluding chapter summarizes the previous chapters. The author considers four cases applied to industrial studies; each is explained in detail.

In summary, this is a practical book that will be useful to those concerned with vibrations and noise control. The book more than adequately answers questions of maintenance engineers and designers concerned with noise and vibration. It is well illustrated and contains many examples. The typographical errors are easily corrected. This book will be of value to persons concerned with combating noise and effectively controlling it.

H. Saunders
General Electric Company
Building 41, Room 319
Schenectady, NY 12345

SHORT COURSES

JULY

FRACTURE MECHANICS I
Dates: July 16-20, 1979
Place: Union College, Schenectady, New York
Objective: This course is designed to illustrate the use of fracture mechanics as a practical tool in engineering design. The institute will benefit those concerned with the application of fracture mechanics to the prevention of fracture in pressure vessels for power generation, for example, or welded structural frameworks for buildings and bridges.

Contact: Office of Graduate Studies and Continuing Education, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

INSTRUMENTATION, MEASUREMENTS ENGINEERING AND APPLICATION
Dates: July 16-20, 1979
Place: Union College, Schenectady, New York
Objective: Major topics will include transducer design, application and limitations, engineering the test program, recording techniques, identifying good and bad data, data reduction and interpretation, and case histories. These will be applied both to static and dynamic measurements.

Contact: Office of Graduate Studies and Continuing Education, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

FRACTURE MECHANICS II WITH INDUSTRIAL APPLICATIONS
Dates: July 23-26, 1979
Place: Union College, Schenectady, New York
Objective: This course is designed for engineers with responsibility and management of fracture analysis and prevention. The course will focus on concepts and methods representing the state-of-the-art as applied in the pressure vessel and piping fields.

Contact: Office of Graduate Studies and Continuing Education, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

WORKSHOP FOR THE ANALYSIS OF ROTOR BEARING SYSTEMS
Dates: July 23-27, 1979
Place: Union College, Schenectady, New York
Objective: A comprehensive survey of the dynamic problems of high speed, flexible rotors will be presented. A full range of rotor-dynamic phenomena will be examined; discussion of theory will be complemented by sample computations of realistic engineering problems.

Contact: Office of Graduate Studies and Continuing Education, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

FINITE ELEMENT METHOD IN MECHANICAL DESIGN
Dates: July 23-27, 1979
Place: University of Michigan
Objective: Applications of the finite element method to practical problems of stress analysis and design are covered. Also included is the derivation of the method from energy principles. Graphics used for data preparation and interpretation of results will be presented.

Contact: Engineering Summer Conferences, 200 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109.

COMPUTER WORKSHOP IN EARTHQUAKE AND STRUCTURAL DYNAMICS
Dates: July 30-August 3, 1979
Place: Union College, Schenectady, New York
Objective: This course will cover structural dynamics techniques for both linear and nonlinear many-degree-of-freedom systems; and random vibration

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and computer graphics for input generation and output generation. Applications to current technological problems, including earthquake analysis, pipe whip dynamics, shock response of electronic cabinets, and fluid-solid interaction, will be discussed.

Contact: Office of Graduate Studies and Continuing Education, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

COMPUTER WORKSHOP IN FINITE ELEMENT METHODS OF ANALYSIS FOR STRESS AND OTHER FIELD PROBLEMS

Dates: July 30-August 3, 1979
Place: Union College, Schenectady, New York
Objective: The objectives of the course are to develop the basic formulations of finite element structural analysis, to examine practical applications and to present Fortran IV computer programs for both 2D and 3D problems. The programs will be applied to tutorial and student generated problems.

Contact: Office of Graduate Studies and Continuing Education, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

AUGUST

THE SCIENTIFIC AND MATHEMATICAL FOUNDATIONS OF ENGINEERING ACOUSTICS

Dates: August 13-24, 1979
Place: Massachusetts Institute of Technology
Objective: The program emphasizes those parts of acoustics -- the vibration of resonators, properties of waves in structures and air -- the generation of sound and its propagation that are important in a variety of fields of application. The mathematical procedures that have been found useful in developing the desired equations and their solutions, and the processing of data are also studied. These include complex notation, fourier analysis, separation of variables, the use of special functions, and spectral and correlation analysis.

Contact: Richard H. Lyon, Massachusetts Institute of Technology, Room 3-366, Dept. of Mech. Engrg., Cambridge, MA 02139.

THE APPLICATION OF VIBRATION MEASUREMENT AND ANALYSIS IN MACHINE MAINTENANCE

Dates: August 14-16, 1979
Place: Los Angeles, California
Dates: August 20-22, 1979
Place: Chicago, Illinois
Dates: November 6-8, 1979
Place: New York, New York
Dates: November 13-15, 1979
Place: Dallas, Texas
Objective: These sessions are designed to give an understanding of the concept of using machinery vibration as a means of detecting wear in rotating parts, and of predicting machinery breakdowns. It will deal with the principles and methods of machine condition analysis and the economic benefits obtainable from condition monitoring. Fundamentals of vibration measurement and analysis are explained with particular reference to optimum choice of measurement parameter and techniques to avoid unnecessary errors and limitations in detection and diagnostic capability.

Contact: B&K Instruments, Inc., Bruel & Kjaer Precision Instruments, 5111 W. 164th St., Cleveland, OH 44142.

VIBRATION AND SHOCK SURVIVABILITY

Dates: August 20-24, 1979
Place: Tustin Institute of Technology
Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis, also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos St., Santa Barbara, CA 93105 - (815) 682-7171.

FINITE ELEMENT APPLICATIONS IN MACHINE DESIGN

Dates: August 27-31, 1979
Place: Tennessee Technological University
Objective: The course will cover basic theories of finite element techniques for force, displacement, and stress-related problems of mechanics and their

applications to the solution of problems in the designs of mechanical systems, machines, and their components. Planar and three-dimensional flexural finite line elements; planar triangular, rectangular, quadrilateral and polar finite stress elements; three-dimensional tetrahedron, hexahedron, prism and polar finite stress elements; and rectangular and triangular finite plate elements will be presented.

Contact: Dr. Cemil Bagci, Dept. of Mech. Engrg., Tennessee Technological University, Cookeville, TN 38501 - (615) 528-3265/528-3254.

MACHINERY VIBRATIONS COURSE

Dates: August 28-30, 1979
Place: Anchorage, Alaska
Objective: This course on machinery vibrations will cover physical/mathematical descriptions, calculations, modeling, measuring, and analysis. Machinery vibrations control techniques, balancing, isolation, and damping, will be discussed. Techniques for machine fault diagnosis and correction will be reviewed along with examples and case histories. Torsional vibration measurement and calculation will be covered.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, Suite 206, 101 W. 55th Street, Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

SEPTEMBER

MACHINERY VIBRATION ANALYSIS

Dates: September 5-7, 1979
Place: Atlantic City, New Jersey
Dates: December 11-13, 1979
Place: New Orleans, Louisiana
Objective: The topics to be covered during this course are: fundamentals of vibration; transducer concepts; machine protection systems; analyzing vibration to predict failures; balancing; alignment; case histories; improving your analysis capability; managing vibration data by computer; and dynamic analysis.

Contact: Spectral Dynamics Corp. of San Diego, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

VIBRATION OF BEAMS, PLATES, AND SHELLS

Dates: September 10-14, 1979
Place: The Ohio State University
Objective: Understanding the natural frequencies and mode shapes of beams, plates and shells as well as their dynamic response to external excitation. A survey of the recent literature and examination of important papers will be included.

Contact: Professor A.W. Leissa, Dept. of Engineering Mechanics, The Ohio State University, 155 West Woodruff Ave., Columbus, OH 43210 - (614) 422-7271.

8th ANNUAL INSTITUTE ON THE MODERN VIEW OF FATIGUE AND ITS RELATION TO ENGINEERING PROBLEMS

Dates: September 10-14, 1979
Place: Union College, Schenectady, New York
Objective: This course will emphasize the relationships of our current physical and phenomenological understanding of fatigue to the engineering treatment of the problem. The curriculum will be built around the several stages of the fatigue process including consideration of the plastic zone, crack nucleation and early growth, crack propagation in the plastic regime, crack propagation in the elastic regime, and failure.

Contact: Office of Graduate Studies and Continuing Education, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

ROTATING MACHINERY VIBRATIONS SEMINAR

Dates: September 18-20, 1979
Place: Boxborough, Massachusetts
Objective: This seminar will feature lectures on fluid film bearings, torque induced lateral vibration, coupling use on rotating machinery, minicomputer use and self-excited vibrations in rotating machinery. Practical aspects of rotating machines will be emphasized.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, Suite 206, 101 West 55th St., Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

DIGITAL SIGNAL PROCESSING

Dates: September 18-20, 1979

Place: Washington, D.C.

Objective: This seminar covers theory, operation and applications – plus additional capabilities such as transient capture, amplitude probability, cross spectrum, cross correlation, convolution coherence, coherent output power, signal averaging and demonstrations.

Contact: Spectral Dynamics Corp. of San Diego, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

OCTOBER

VIBRATION CONTROL

Dates: October 8-12, 1979

Place: The Pennsylvania State University

Objective: The seminar will be of interest and value to engineers and scientists in industry, government, and education. Topics include dynamic mechanical properties of viscoelastic materials; structural damping; isolation of machinery vibration from rigid and nonrigid substructures; isolation of impact transients; reduction of vibration in beams, plates, and shells; reduction of the flow-induced vibration of complex structures; case histories in vibration reduction; and characteristics of multi-resonant vibrators.

Contact: Professor John C. Snowdon, Seminar Chairman, Applied Research Lab., The Pennsylvania State University, P.O. Box 30, State College, PA 16801 - (814) 865-6364.

MACHINERY VIBRATIONS SEMINAR

Dates: October 23-25, 1979

Place: Mechanical Technology Inc., Latham, NY

Objective: To cover the basic aspects of rotor-bearing system dynamics. The course will provide a fundamental understanding of rotating machinery vibrations; an awareness of available tools and techniques for the analysis and diagnosis of rotor vibration problems; and an appreciation of how these techniques are applied to correct vibration problems. Technical personnel who will benefit most from this course are those concerned with the rotor dynamics evaluation of motors, pumps, turbines, compressors, gearing, shafting, couplings, and similar mechanical equipment. The attendee should possess an engineering degree with some understanding of mechanics of materials and vibration theory. Appropriate job functions include machinery designers; and plant, manufacturing, or service engineers.

Contact: Mr. Paul Babson, MTI, 968 Albany-Shaker Rd., Latham, NY 12110 - (518) 785-2371.

ROTATING MACHINERY VIBRATIONS COURSE

Dates: October 29-November 1, 1979

Place: Cherry Hill, New Jersey

Objective: This advanced course on rotating machinery vibrations will cover physical/mathematical modeling, mathematical computations, physical descriptions of vibration parameters, measuring, and analysis. Machinery vibrations control techniques will be discussed. Torsional vibration measurement, analysis, and control will be reviewed.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, Suite 206, 101 West 55th St., Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

NOVEMBER

VIBRATION DAMPING

Dates: November 5-8, 1979

Place: University of Dayton Research Institute

Objective: Topics to be covered are: damping behavior of materials, response measurements of damped systems, surface damping treatments on vibrating members, discrete damping devices, special analytical problems, increasing linear viscoelastic material properties, damping of acoustic vibrations, selected case histories, problem solving sessions, and demonstration of digital fast fourier analyses.

Contact: Mrs. Audrey G. Sachs, University of Dayton Research Institute, Dayton, OH 45469 - (513) 229-2919.

DYNAMIC ANALYSIS WORKSHOP

Dates: November 5-9, 1979

Place: San Diego, California

Objective: This course will cover the latest techniques of analyzing noise and vibration in rotating

machinery and power-driven structures. The workshop will cover both the theory and practical aspects of tracking down malfunctions and preventing failures caused by unbalance, misalignment, wear, oil whirl, etc. Included in the course will be demonstrations and practical, hands-on experience with the latest noise and vibration instrumentation; Real Time Analyzers, FFT Processors, Transfer Function Analyzers and Computer-Controlled Modal Analysis Systems. Actual case histories and specific machinery signatures will be discussed.

Contact: Spectral Dynamics Training Manager, P.O. Box 671, San Diego, CA 92112 - (714) 565-8211.

CONTROLLING THE EFFECTS OF PULSATIONS AND FLUID TRANSIENTS IN PIPING SYSTEMS

Dates: November 7-9, 1979
Place: San Antonio, Texas

Objective: The seminar will cover various means for preventing and controlling the detrimental effects of pulsations and fluid transients on piping, pumps, compressors, and other plant systems and equipment. Topics will include: pulsation generation mechanisms and their effects in plant piping and equipment; the SGA Compressor Installation Simulator (SGA Analog) and its applications; pulsation control and piping system design; mechanical response of plant components to pulsations and transient excitation; vibration control in piping systems; vibration-induced stress and meaningful stress criteria; transient fluid interaction of system components (flow instabilities, cavitation, flashing, piping effects on surge, etc.); effects and control of pulsations in flow measurement; and pulsation effects on the performance of compressor/pump installations.

Contact: Joe L. Gulinson, Southwest Research Institute, P.O. Drawer 28510, San Antonio, TX 78284 - (512) 684-5111, Ext. 2521.

NEWS BRIEFS

news on current and Future Shock and Vibration activities and events

EIGHTH TURBOMACHINERY SYMPOSIUM

The Gas Turbine Laboratories at Texas A&M University announce their "Eighth Turbomachinery Symposium" to be held at the Shamrock Hilton Hotel in Houston, Texas, November 27, 28, & 29, 1979.

The object of the Symposium is to provide interested persons with the opportunity to learn the applications and principles of various types of turbomachinery, to enable them to keep abreast of the latest developments in this field and to provide a forum wherein those who attend can exchange ideas. In this exchange of information, users, manufacturers, basic design engineers, and technicians will get together and discuss problem areas. They will also attend lectures that will inform them of the latest developments in the area of turbomachines and related equipment.

The tentative program is as follows:

LECTURES: Bearings - A User's Viewpoint; Selection and Design of Tilting Pad and Fixed Lobe Bearings; Electronic Governors; Governors - A User's Viewpoint; Bearing Failure Detection Designs; Compressor Wheel Problems; Instabilities in Pumps; Sound Controls; Cogeneration and Bottoming Cycle; Gear Box Problems; Small Gas Turbine Problems; Maintenance Techniques; Couplings - A User's Point of View; and Use of Multiple Fuels.

DISCUSSIONS: Compressor Operation and Maintenance; Gas Turbine and Driven Equipment; Steam Turbine Operation and Maintenance; Shop Techniques for Repair and Maintenance of Turbomachinery; and Onstream Testing of Protection Devices.

PANEL SESSION: A special panel session on API specifications relating to turbomachinery will be held.

ANNOUNCEMENT AND CALL FOR PAPERS

Symposium on Computational Methods in Nonlinear Structural and Solid Mechanics

This symposium will be held at the Sheraton National Motor Hotel, Washington, D.C. on October 6-8, 1980. It will be co-sponsored by The George Washington University and NASA Langley Research Center.

The purpose of the symposium is to provide multidisciplinary medium for communicating recent and projected advances in numerical analysis, applied mechanics, computer hardware, computer software and their impact on the modeling and solution of nonlinear structural and solid mechanics problems. Papers are invited on the following topics: continuum basis for nonlinear phenomenon, material characterization and strength theories, computational strategies and adaptive methods, special requirements for nonlinear software systems, potential of minicomputers, supercomputers, distributed processors and microprocessors for nonlinear analysis. Among the application areas considered are: vehicle crashworthiness, reinforced concrete and fibrous composite structures, earthquake resistant structures and nuclear reactor design.

Authors should submit three copies of an extended abstract of about 1,000 words prior to November 2, 1979. Three copies of the final manuscript will be due by April 28, 1980. Papers accepted for presentation will be published before the meeting in a bound volume and will be considered for publication in the Journal of Computers and Structures.

One page abstracts are also solicited on current research in progress for presentations at special sessions. For further information contact:

Professor Ahmed K. Noor
Mail Stop 246
The George Washington University
NASA Langley Research Center
Hampton, Virginia 23665
(804) 827-2897

ABSTRACTS FROM THE CURRENT LITERATURE

Copies of articles abstracted in the DIGEST are not available from the SVIC or the Vibration Institute (except those generated by either organization). Inquiries should be directed to library resources. Government reports can be obtained from the National Technical Information Service, Springfield, VA 22151, by citing the AD-, PB-, or N- number. Doctoral dissertations are available from University Microfilms (UM), 313 N. Fir St., Ann Arbor, MI; U.S. Patents from the Commissioner of Patents, Washington, D.C. 20231. Addresses following the authors' names in the citation refer only to the first author. The list of periodicals scanned by this journal is printed in issues 1, 6, and 12.

ABSTRACT CONTENTS

ANALYSIS AND DESIGN

ANALYTICAL METHODS

79-1102

Approximate Eigenvalues for Systems with Variable Parameters

S.C. Sinha and C.C. Chou
Dept. of Mech. Engrg., Kansas State Univ., Manhattan, KS 66506, J. Appl. Mech., Trans. ASME, 46 (1), pp 203-205 (Mar 1979) 3 figs, 9 refs

Key Words: Eigenvalue problems, Dynamic buckling, Columns

The paper deals with an approximate analytical technique for solving the boundary-value problems governed by second-order differential equations with variable coefficients. The variable coefficient appearing in the system equation is expanded in ultraspherical polynomials in the desired interval to construct simple equivalent functions such that the approximate differential equations thus obtained have known closed form solutions. The method is applied to calculate the critical buckling load for a column of exponentially varying moment of inertia. The technique is quite general and does not require any restriction on system parameters.

79-1103

Effects of Normal and Extreme Environment on Reinforced Concrete Structures

B. Bresler and R.H. Iding
Div. of Structural Engrg. and Structural Mech., California Univ., Berkeley, CA, Rept. No. UCSESM-77-4, NSF/RA-770674, 81 pp (May 1977)
PB-287 439/4GA

Key Words: Dynamic structural analysis, Reinforced concrete

Prediction of the response of reinforced concrete structures to variations in temperature, humidity, and load is described. Modeling of structures, loading history, environment, and material behavior is discussed and several case studies are included to illustrate the use of proposed models. The models account for nonlinear behavior under variations in load and environment, and for the nonhomogeneity introduced by steel reinforcement and cracking of concrete.

NONLINEAR ANALYSIS

79-1104

Some Questions on Nonlinear Deformation in Solids

N.M. Panfero and V.N. Kuznetsov
NASA, Washington, D.C., Rept. No. NASA-TT-F-17162, 140 pp (Dec 1978) (Engl. transl. from Moscow State Univ. Inst. of Mech. Sci. Trans. Moscow, no. 8, 1971, pp 1-107)
N79-13404

Key Words: Nonlinear response, Isotropy, Anisotropy

A collection dedicated to the theoretical and experimental studies of some nonlinear problems of deformed solid bodies is presented. Studies include: the physical nonlinearity of the deformation of isotropic and anisotropic solids; the geometrical nonlinearity in problems about stability with respect to final perturbations of elastic cylindrical shells; the methods of solving nonlinear boundary value problems of thermoviscoelasticity and thermal conductivity; and the behavior of constructions in case of dynamical loading. Different analytical and experimental ways and methods are proposed for solving these problems; solutions of special problems are also given.

NUMERICAL ANALYSIS

79-1105

Elastodynamic Response of a Penny-Shaped Crack in a Cylinder of Finite Radius

E.P. Chen
Dept. of Mech. Engrg. and Mechanics and Inst. of Fracture and Solid Mechanics, Lehigh Univ., Bethlehem, PA 18015, Intl. J. Engr. Sci., 17 (4), pp 379-385 (1979) 3 figs, 1 table, 8 refs

Key Words: Numerical analysis, Elastodynamic response, Cylinders, Cracked media, Discontinuity-containing media

The elastodynamic response of a penny-shaped crack in a cylinder of finite radius is investigated in this study. A step

stress is applied to the crack surface resulting in transient behavior. The stress field near the crack front and the dynamic stress intensity factor are determined. Numerical results for the dynamic stress intensity factor are obtained to show the influence of inertia, geometry and their interactions on the load transfer to the crack.

79-1106
Numerical Spatial Marching Techniques in Duct Acoustics
K.J. Baumeister
NASA Lewis Res. Center, Cleveland, OH 44135, J. Acoust. Soc. Amer., 65 (2), pp 297-306 (Feb 1979) 13 figs, 23 refs

Key Words: Ducts, Sound pressure, Numerical analysis

A numerical method is developed that predicts the pressure distribution of a ducted source from farfield pressure inputs. Using an initial value formulation, the two-dimensional homogeneous Helmholtz wave equation (no steady flow) is solved using explicit marching techniques. The Von Neumann method is used to develop relationships which describe how sound frequency and grid spacing effect numerical stability. Sample calculations for both hard and soft wall ducts compare favorably to known boundary value solutions. This initial value approach is successfully used to determine the attenuation of a straight soft wall duct.

OPTIMIZATION TECHNIQUES
(Also see No. 1117)

79-1107
Optimal Design of Coupled Dynamic Systems with Time-Varying Stiffness
M.C. Benton
Ph.D. Thesis, The Univ. of Wisconsin-Madison, 340 pp (1978)
UM 7823047

Key Words: Optimum design, Coupled systems, Time-dependent parameters, Periodic excitation

This study investigates the uncoupling of the equations of motion of dynamic systems with time-varying stiffness subjected to periodic excitation. A normal mode approach is used for formulating the dynamic equations. A procedure is given for investigating the instability regions of the coupled system utilizing the uncoupled equations. The forced response and peak resonant points are evaluated using the Ritz Averaging method for sinusoidal stiffness fluctuation and piecewise analysis for the rectangular case. The optimal design of frictionally damped absorbers for gear systems is considered. General design data are determined and can be directly used for the selection of the optimal parameters for a given system.

STATISTICAL METHODS
(See Nos. 1109, 1238)

MODELING

79-1108
Frequency Response of Non-Linear Single Degree-of-Freedom Systems
K. Peleg
School of Packaging, Michigan State Univ., East Lansing, MI 48824, Intl. J. Sci., 21 (2), pp 75-84 (1979) 7 figs, 9 refs

Key Words: Frequency response method, Mathematical models

A realistic model to predict the response of practical systems to vibration excitation is proposed. It consists of a mass between two preloaded non-linear (cubic elasticity springs) and restrained by a Coulomb and viscous damper. A harmonic motion solution, satisfying "on the average" the non-linear differential equation of motion of the model is developed whereby equations for frequency response curves are obtained. Expressions for relative and absolute transmissibility as well as their values at resonance are developed.

DIGITAL SIMULATION
(Also see No. 1257)

79-1109
Simulation of Space-Random Fields for Solution of Stochastic Boundary-Value Problems
I. Elishakoff
Dept. of Aeronautical Engrg., Technion-Israel Inst. of Tech., Haifa, Israel, J. Acoust. Soc. Amer., 65 (2), pp 399-403 (Feb 1979) 31 refs

Key Words: Boundary value problems, Stochastic processes, Digital simulation, Mode shapes

The technique of digital simulation of Gaussian random fields (which are nonhomogeneous in space or are part of homogeneous random fields in space) is presented to a solution of stochastic boundary-value problems. The method consists of expanding the simulated field, with known mean and autocorrelation function, in series in terms of the structural natural mode shapes, and the Fourier coefficients of the truncated series are then simulated as random normal vectors. The method is applicable to static or dynamic stochastic two-point boundary-value problems in mechanics of solids.

PARAMETER IDENTIFICATION

79-1110

System Identification, Damage Assessment, and Reliability Evaluation of Structures

E.C. Ting, S.J.H. Chen, and J.T.P. Yao

School of Civil Engrg., Purdue Univ., Lafayette, IN, Rept. No. CE-STR-78-1, NSF/RA-780325, 69 pp (Feb 1978)

PB-288 889/9GA

Key Words: System identification technique, Damage, Reliability, Earthquake resistant structures

Available literature on the methods of structural identification, damage assessment, and reliability evaluation are reviewed and summarized. The possibility of combining those techniques into a rational procedure for practical implementation is discussed. The available literature has been presented in tabular form. Several recommended procedures for inspection and safety assessment are reviewed and summarized. The possible incorporation of system identification techniques into damage assessment is also discussed.

79-1111

Parameter Identification Applied to Analytic Hingeless Rotor Modeling

D. Banerjee, S.T. Crews, and K.H. Hohenemser

Hughes Helicopters, Culver City, CA, J. Amer. Helicopter Soc., 24 (1), pp 26-32 (Jan 1979) 12 figs, 3 tables, 15 refs

Key Words: Parameter identification technique, Transient response, Helicopter rotors, Mathematical models

Two analytical inflow models are studied: the first is based on an equivalent blade Lock number, the second is based on a time delayed unsteady momentum inflow. Identifications from simulated test data and an eigenvalue analysis are performed. Prediction studies with experimental data not used for the identification are performed to determine the accuracy of the mathematical models.

CRITERIA, STANDARDS, AND SPECIFICATIONS

(Also see No. 1266)

79-1112

Noise Zoning Around Airports in the Federal Republic of Germany According to the Air Traffic Noise Act

A.O. Vogel

Federal Ministry of the Interior, Bonn, Federal Rep. of Germany, Noise Control Engr., 12 (1), pp 20-21 (Jan-Feb 1979) 6 refs

Key Words: Aircraft noise, Regulations

The Air Traffic Noise Act provides protection from aircraft noise and calls for the establishment of noise protection areas around airports. Each of the areas is divided into two zones according to the level of noise exposure. Statutory decrees for noise protection areas are already in effect for all ten commercial airports and twenty-one of the more than thirty military airfields falling under the act. The author summarizes the background and developments in this legislation.

79-1113

German Federal Regulation for Sound Insulation Against Aircraft Noise

H. Gummlich and H. Reich

Federal Ministry of the Interior, Bonn, Federal Rep. of Germany, Noise Control Engr., 12 (1), pp 22-25 (Jan-Feb 1979) 1 table, 10 refs

Key Words: Buildings, Aircraft noise, Noise reduction, Regulations

Authorized by the Air Traffic Noise Act, the German federal government issued the Decree on Sound Insulation. This decree establishes sound insulation requirements for buildings

in the noise protection area. Compliance with these requirements is a condition for obtaining a building permit for new buildings and for receiving reimbursement for sound insulation modifications in existing buildings. The main features of the decree are described with an estimate of the noise level reduction inside buildings meeting the requirements.

79-1114

A Review of Worldwide Automotive Noise Legislation

D. Morrison

Noise Dept., Ricardo & Co. Engineers (1927), Ltd., Noise Control Vib. Isolation, 9 (9), pp 377-380 (Nov /Dec 1978) 2 figs, 6 refs

Key Words: Ground vehicles, Motor vehicle noise, Regulations

Automotive noise regulatory procedures and limits are outlined for the major world markets: Europe, the USA and Japan. Some of the events leading up to present day legislation are highlighted and the current noise regulations summarized for each of the three regions. Future trends are estimated and generally expected to represent a compromise between technical feasibility, economic considerations and environmental acceptability.

79-1115

Plan for the Assessment and Implementation of Seismic Design Provisions for Buildings

C.C. Culver, R.E. Chapman, P.W.Cooke, B.R. Ellingwood, and S.G. Fattal

Center for Building Tech., National Engrg. Lab. (NBS), Washington, D.C., Rept. No. NBSIR-78-1549, 31 pp (Oct 1978)

PB-288 762/8GA

Key Words: Earthquake resistant structures, Seismic design, Buildings, Standards and codes

This plan deals with the assessment and implementation of tentative seismic design provisions developed by the Applied Technology Council as part of the Cooperative Federal Program in Building Practices for Disaster Mitigation of the National Science Foundation and the National Bureau of Standards. The plan was prepared based on comments received from a broad spectrum of representatives of the building community. The plan includes four phases: Review and Refine Tentative Provisions; Trial Designs and Impact Assessment; Consideration and Adoption of Provisions; and Assistance to Facilitate Implementation. It can form the basis for the assessment and implementation of the tentative seismic design provisions.

SURVEYS AND BIBLIOGRAPHIES

79-1116

The Status of Rotor Noise Technology: One Man's Opinion

R.P. White, Jr.

RASA Div., Systems Research Labs., Inc., Dayton, OH, In: NASA Langley Res. Ctr. Helicopter Acoustics, Pt. 2, pp 723-780 (Aug 1978) (for primary document see N79-10843)

N79-10862

Key Words: Rotors (machine elements), Noise generation, Reviews

The problem of establishing the state of the technology is approached by first identifying the various characteristics of rotor noise and then assessing the state of technology in understanding and predicting the most important of these rotor noise characteristics in a real-world environment.

79-1117

Structural Optimization Under Shock and Vibration Environment

S.S. Rao

Dept. of Mech. Engrg., Indian Inst. of Tech., Kanpur-208016, India, Shock Vib. Dig., 11 (2), pp 3-12 (Feb 1979) 67 refs

Key Words: Reviews, Optimization, Natural frequencies, Flutter, Chatter

Structural optimization problems are classified according to major constraint – e.g., natural frequency, flutter, dynamic response, and chatter stability. Each class is discussed. Approximate analysis techniques and some recent work on optimization methods, as applied to the design of structures, are presented. Structural optimization problems in need of further investigation are summarized.

79-1118

Stability Problems on Rotor Systems

T. Iwatsubo

Faculty of Engrg., Kobe University, Rokko Nada Kobe 657, Japan, Shock Vib. Dig., 11 (3), pp 17-26 (Mar 1979) 3 figs, 1 table, 26 refs

Key Words: Reviews, Self-excited vibrations, Rotating structures

This article reviews self-excited lateral vibrations that cause instability of rotating machinery. The following causes of instability are described: internal damping, dry friction, journal bearing (oil whip), fluid forces, ball bearings, universal joint, and asymmetric factors.

79-1119

Analysis Techniques of Experimental Frequency Response Data

M. Rades

Polytechnic Inst., Bucharest, Romania, Shock Vib. Dig., 11 (2), pp 15-24 (Feb 1979) 84 refs

Key Words: Reviews, Frequency response method

A review is given of techniques for frequency-domain post test analysis of vibration data. Emphasis is on procedures for curve fitting algebraic expressions of transfer functions to experimentally measured frequency response data for systems with nonproportional damping and/or closely spaced modes.

79-1120

A Review of Approximate Methods for Determining the Vibrational Modes of Membranes

J. Mazumdar

Dept. of Appl. Mathematics, The Univ. of Adelaide, South Australia, Shock Vib. Dig., 11 (2), pp 25-29 (Feb 1979) 36 refs

Key Words: Reviews, Membranes

This review is a follow-up of an earlier review of approximate methods for determining vibrational modes of membranes published in 1975. The earlier review described the world literature from the time of Chladni (1802) until the end of 1974. The present review is restricted to the period from 1975 to date.

79-1121

Dynamic Snap-Through of Shallow Arches and Spherical Caps

S.M. Holzer

Dept. of Civil Engrg., Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, Shock Vib. Dig., 11 (3), pp 3-6 (Mar 1979) 23 refs

Key Words: Reviews, Arches, Spherical shells, Snap-through problems

This article reviews the current literature on effects of asymmetric perturbation and the spatial distribution of the load on dynamic snap-through of shallow arches and spherical caps.

79-1122

A Survey of Finite Element-Related Techniques as Applied to Acoustic Propagation in the Ocean. Part 1: Finite Element Method and Related Techniques

A.J. Kalinowski

Naval Underwater Systems Ctr., New London, CT 06303, Shock Vib. Dig., 11 (3), pp 9-16 (Mar 1979) 1 fig, 59 refs

Key Words: Reviews, Underwater sound, Finite element technique

This two part article deals with finite element-related techniques applied to acoustic propagation in the ocean. Methods for modeling and simulation of boundary conditions are discussed including the related Boundary Solution Method and the Boundary Integral Method in Part 1 and transparent boundary simulation techniques in Part 2.

MODAL ANALYSIS AND SYNTHESIS

79-1123

A Substructure Technique for Nonlinear Static and Dynamic Analysis

D.G. Row and G.H. Powell

Earthquake Engrg. Research Ctr., California Univ., Richmond, CA, Rept. No. UCB/EERC-78/15, NSF/RA-780290, 204 pp (Aug 1978)

PB-288 077/1GA

Key Words: Component mode synthesis, Building block approach

In this study a building block procedure for structural description is presented which is a generalization of standard finite element assembly. The relation of each actual substructure to the complete structure is mapped through a connectivity tree. This tree provides the basis for data management and implementation of a systematic analysis procedure. The technique is formulated for nonlinear static and dynamic step-by-step analysis. Procedures for the direct solution of linear algebraic equations are reviewed and a Cholesky based algorithm is presented which minimizes the computational effort at each step. The substructure technique is implemented for nonlinear static analysis. The flexibility and efficiency of the technique are illustrated by performing substructure and conventional analyses on example structures.

79-1124
A Substructure Technique for Nonlinear Static and Dynamic Analysis
D.G. Row
Ph.D. Thesis, Univ. of California, Berkeley, 191 pp (1978)
UM 7904588

Key Words: Component mode synthesis, Building block approach

In this study a building block procedure for structural description is presented which is a generalization of standard finite element assembly. The relation of each actual substructure to the complete structure is mapped through a connectivity tree. This tree provides the basis for data management and implementation of a systematic analysis procedure. The technique is formulated for nonlinear static and dynamic step-by-step analysis. Procedures for the direct solution of linear algebraic equations are reviewed and a Cholesky based algorithm is presented which minimizes the computational effort at each step. The substructure technique is implemented for nonlinear static analysis. The flexibility and efficiency of the technique are illustrated by performing substructure and conventional analyses on example structures.

79-1125
Measurement of Modal Data and the Application to the Reduction of Radiated Noise
R.S. Reed, Jr.
Ph.D. Thesis, Univ. of Maryland, 164 pp (1978)
UM 7905459

Key Words: Modal analysis, Noise reduction

Modal extraction techniques are presented with methods which the author has developed to improve their effectiveness. This thesis uses the more generalized state variable approach, which avoids some difficulties in the lumped parameter approach. The general state variable model of a vibrating structure and the associated radiated noise is derived. Measurement and analysis techniques are presented which allow the experimental determination of a specific model of a realistic structure which is vibrating and radiating noise in a natural environment. A technique for isolation of eigenvalues is developed and demonstrated. State variable techniques are used to predict the effects of mass, stiffness, and damping modifications on the vibrations of the structure and associated noise.

COMPUTER PROGRAMS

GENERAL

(Also see No. 1142)

79-1126
Collateral Air Blast Damage
J.R. Rempel and C.K. Wiehle
SRI International, Menlo Park, CA, Rept. No. DNA-4609Z, AD-E300 349, 103 pp (Apr 1978)
AD-A060 798/6GA

Key Words: Computer programs, Nuclear explosions, Air blast, Damage prediction, Buildings, Structural members, Walls, Floors

SRI International has been participating in a program to develop a collateral damage methodology for evaluating air blast damage to existing structures that would result from the use of tactical nuclear weapons in small towns and villages located in Western Europe. To increase the applicability of the SRI structural element computer programs for collateral damage predictions, a building subsystem program is developed. The program, BRACOB (Blast Response and Collapse of Buildings), simultaneously analyzes the response of all exterior walls on one story level of a building. The program calculates the separate responses of exterior unreinforced masonry walls to an air blast that sweeps over the building at normal incidence. Three kinds of input are required: air blast description (e.g., peak free-field overpressure, weapon

yield, and ambient conditions), *floor plan information* and wall structural properties (e.g., density, flexural strength, and in-plane vertical load).

79-1127
The Underwater Shock Analysis (USA) Code, A Reference Manual
J.A. DeRuntz, T.L. Geers, and C.A. Felippa
Palo Alto Res. Lab., Lockheed Missiles and Space Co., Inc., Palo Alto, CA, Rept. No. LMSC/D624328, DNA-4524F, AD-E300 369, 142 pp (Feb 28, 1978)
AD-A061 443/8GA

Key Words: Computer programs, Submerged structures, Underwater structures, Shock waves, *Blast effects*

This report constitutes a reference manual for the Underwater Shock Analysis (USA) Code, a computer program for calculation of the transient response of a submerged structure to a spherical shock wave of arbitrary pressure profile and source location. The code considers the structure to be linear-elastic and treats the surrounding fluid as an infinite acoustic medium. A discrete-element (finite-element, finite-difference) computational model is used for the structure, while the computational model for the fluid is based upon the Doubly Asymptotic Approximation.

ENVIRONMENTS

ACOUSTIC

(Also see Nos. 1112, 1113, 1122, 1147, 1148, 1165, 1173, 1217, 1248, 1252)

79-1128
Evaluation of the Relative Importance of Circumferential or Creeping Waves in the Acoustic Scattering from Rigid and Elastic Solid Cylinders and from Cylindrical Shells
L.R. Dragonette
Naval Research Lab., Washington, D.C., Rept. No. NRL-8216, 68 pp (Sept 22, 1978)
AD-A060 836/4GA

Key Words: Acoustic scattering, Cylindrical shells, Finite element technique

The relationship is determined between predicted circumferential waves on cylinders and the normal-mode series solution for the acoustic scattering by submerged metal cylinders.

79-1129
Excitation of Nonlinear Acoustic Resonances by Unsteady Heat Input
D.S. Whitehead and D.K. Holger
Dept. of Engrg., Univ. of Cambridge, Cambridge, CB2 1PZ, UK, J. Acoust. Soc. Amer., 65 (2), pp 324-335 (Feb 1979) 14 figs, 18 refs

Key Words: Acoustic resonance, Thermal excitation

Experiments are carried out on a cylindrical cavity containing hydrogen, the unsteady heat input being supplied by a modulated electric arc. A nonlinear acoustic theory is extended to deal with unsteady heat input. An approximate theoretical criterion for the appearance of shock waves is derived.

79-1130
Noise Transmission Through Flat Rectangular Panels into a Closed Cavity
C.K. Barton and E.F. Daniels
NASA Langley Res. Center, Hampton, VA, Rept. No. NASA-TP-1321; L-12439, 29 pp (Dec 1978)
N79-14874

Key Words: Panel-cavity response, Sound transmission

Five panels backed by a closed cavity are studied experimentally and analytically to determine the noise transmission characteristics of the coupled panel-cavity system. The closed cavity is studied both with and without fiberglass lining to provide either an absorbent or a reverberant acoustic space. The effects on noise reduction of cavity absorption, measurement location within the cavity, panel mass, and panel stiffness are examined. A simple, one-dimensional analytical model is developed which provides good agreement with the experimental results.

79-1131
Engineering Methods for Measuring and Computing the Acoustical Transmission of Machine Structures

W. Schirmer
Central Inst. of Occupational Safety, Gerhart-Hauptmann-Str. 1, 8020 Dresden, German Democratic Republic, Noise Control Engr., 12 (1), pp 31-37 (Jan-Feb 1979) 9 figs, 8 refs

Key Words: Sound transmission, Machinery noise, Measurement techniques, Measuring instruments

A simple device for measuring the acoustical transmission in machine structures such as frames or casings is described. The measured results are compared with computed results. In addition, well-known methods of computation are extended by an engineering method for the computation of the radiation ratio of machine parts, in particular by relating their characteristics to those of a monopole or dipole.

79-1132
Measurement of Fundamental and Second Harmonic Pressures in the Field of a Circular Piston Source
M.B. Moffett
New London Lab., Naval Underwater Systems Ctr., New London, CT 06320, J. Acoust. Soc. Amer., 65 (2), pp 318-323 (Feb 1979) 6 figs, 35 refs

Key Words: Underwater sound, Harmonic response, Experimental data

Measurements are made at various ranges between 1 and 131 m of the fundamental and second harmonic components of a finite-amplitude sound wave produced by a 10.2-cm diam projector driven at 450 kHz in fresh water. Various levels are used so that nonsaturated as well as saturated conditions are obtained.

79-1133
A Study of the Effects of Ocean Bottom Roughness on Low-Frequency Sound Propagation
S.R. Rutherford, K.E. Hawker, and S.G. Payne
Applied Research Labs., Univ. of Texas at Austin, TX 78712, J. Acoust. Soc. Amer., 65 (2), pp 381-386 (Feb 1979) 7 figs, 1 table, 16 refs

Key Words: Sound propagation, Underwater sound

The effects of bottom (water-sediment interface) roughness on low-frequency sound propagation is examined using a theory of scattering based on boundary conditions applied at the mean boundary. Boundary roughness effects on normal mode attenuation coefficients are examined for two sediment types and two frequencies.

79-1134
Mathematical Modelling of Textile Weave Room Sound Propagation
H.D. Eckhardt
Rockwell-Draper Inc., Hopedale, MA 01747, J. Engr. Indus., Trans. ASME, 101 (1), pp 69-72 (Feb 1979) 4 figs, 5 refs

Key Words: Textile looms, Noise prediction

This paper describes a weave room sound level prediction technique which involves the use of ray tracing and superposition computer programs whose validity has been verified by comparison with measured data.

PERIODIC
(Also see No. 1107)

79-1135
Amplitude Modulation of a Forced System by Parameter Variation
K. Eisinger and H.C. Merchant
Marine Systems, The Boeing Co., P.O. Box 3707, MS 61-35, Seattle, WA 98124, J. Appl. Mech., Trans. ASME, 46 (1), pp 191-196 (Mar 1979) 9 figs, 1 table, 7 refs

Key Words: Parameter amplification

Classical (primary) parametric amplification is reviewed. A high-order phenomenon that is identified as secondary parametric amplification (or attenuation), is discussed in detail and solutions related to Mathieu's equation are presented.

79-1136
Clamped Beam Parametric Amplifier
K. Eisinger and H.C. Merchant
Marine Systems, The Boeing Co., P.O. Box 3707,

MS 61-35, Seattle, WA 98124, J. Appl. Mech., Trans. ASME, 46 (1), pp 197-202 (Mar 1979) 9 figs, 4 refs

Key Words: Parameter amplification, Clamped beams, Harmonic excitation, Flexural excitation

Parametric amplification of the transverse motion of a uniform, clamped beam with a center mass is investigated. The system inputs are a transverse harmonic motion and a compressive load (with harmonic and static components) applied at the beam supports. Secondary parametric amplification is considered by the application of end-loads at frequencies near the system characteristic frequency and transverse support motions at frequencies much lower than the characteristic frequency. An example of an inertial sensing element for a gravimeter is presented.

RANDOM

79-1137

Some Observations on the Random Response of Linear and Nonlinear Dynamical Systems

A.B. Mason

Ph.D. Thesis, California Inst. of Tech., 127 pp (1978) UM 7906212

Key Words: Dynamic systems, Nonlinear systems, Linear systems, Random response

In this thesis, two problems are investigated which commonly arise in the study of the response of randomly excited discrete dynamical systems. First is the problem of obtaining the nonstationary stochastic response of a nonlinear system subject to deterministically modulated stationary Gaussian random excitation. An extension of the generalized method of equivalent linearization is used to obtain an approximation to this response. The accuracy of this approximate technique is investigated by means of Monte Carlo simulation. Secondly is the first passage problem for the stationary response of a lightly damped linear oscillator excited by white noise. A method is developed to generate approximate values for the limiting decay rate of the corresponding first passage probability density. This method is extended so that an approximate first passage probability distribution may be calculated when the oscillator response is nonstationary. The accuracy of this approximate distribution is examined.

79-1138

Hysteretic Structural Vibrations Under Random Load

P.-T.D. Spanos

Dept. of Aerospace Engrg. and Engrg. Mechanics, Univ. of Texas, Austin, TX 78712, J. Acoust. Soc. Amer., 65 (2), pp 404-410 (Feb 1979) 6 figs, 1 table, 28 refs

Key Words: Random response, Hysteretic damping

The nonstationary and stationary response of a lightly damped hysteretic structural system to white random load are considered. The hysteretic behavior is examined by using a model consisting of an infinite collection of elastoplastic elements, the yield loads of which are probabilistically specified. An equivalent linear system is constructed for the original hysteretic system. This system is used to obtain approximate solutions for the statistics of the response amplitude. The analytical results are used to perform a variety of parameter studies.

SEISMIC

(Also see Nos. 1199, 1200, 1204, 1216, 1230, 1231, 1232, 1233, 1234, 1235, 1238)

79-1139

Seismic Earth Pressures on Embedded Structures

C. Tsai

Ph.D. Thesis, Univ. of California, Berkeley, 139 pp (1978) UM 7904634

Key Words: Interaction: soil-structure, Seismic response

An analytical procedure for the determination of seismic responses of a soil-structure system as well as the evaluation of seismic earth pressures on the embedded structures is presented. This procedure utilizes the finite element approach which not only includes the use of viscous boundary for approximate three-dimensional simulation but also replaces the layered soils connected to both ends of the finite element model by the transmitting boundaries. Three different soil-structure systems with one or more structures are studied by using this procedure.

79-1140

Determining Models of Structures from Earthquake Records

J.L. Beck

Earthquake Engrg. Research Lab., California Inst. of Tech., Pasadena, CA, Rept. No. EERL-78-01, 309 pp (June 1978)
PB-288 806/3GA

Key Words: System identification technique, Seismic response, Modal minimization method, Buildings

The problem of determining linear models of structures from seismic response data is studied using ideas from the theory of system identification. The investigation employs a general formulation called the output-error approach, in which optimal estimates of the model parameters are obtained by minimizing a selected measure-of-fit between the responses of the structure and the model. Two output-error techniques are investigated. A new technique, called the modal minimization method, is developed. The modal minimization method is applied to two multi-story buildings that experienced the 1971 San Fernando earthquake. The time-varying character of the equivalent linear parameters is also studied for both buildings.

79-1141
Earthquake Response of Inelastic Structural Systems
O.A. Lopez
Ph.D. Thesis, Univ. of California, Berkeley, 89 pp (1978)
UM 7904527

Key Words: Earthquake response, Seismic response, Single degree of freedom systems, Buildings, Mathematical models

This study of response of simple structural systems to earthquake ground motion is presented in two parts: The response of linear elastic and nonlinear hysteretic systems having a single degree of freedom to recorded and simulated ground motions is studied. The objective is to evaluate whether the commonly used simulated motions are appropriate for predicting inelastic response of structures and elastic response of long period structures. In part two, the response of idealized one-story structural systems to earthquake ground motion is computed with the objective of evaluating the effects of gravity loads and vertical ground motions.

79-1142
A Rational Approach to Damage Mitigation in Existing Structures Exposed to Earthquakes
Earthquake Engrg. Systems, Inc., San Francisco, CA, Rept. No. NSF/RA-780299, 95 pp (May 1978)
PB-288 365/0GA

Key Words: Earthquake resistant structures, Damage prediction, Structural members, Computer programs

This study examines the feasibility of developing a rational decision analysis methodology to be used by building owners and managers as well as the financial and insurance industries in the evaluation of possible modification schemes for existing buildings exposed to a predicted earthquake. Available procedures to determine the expected earthquake hazard at a given site are studied, and a methodology to apply the results of these procedures to the decision-making process is presented. A procedure to calculate the damages to various components of a building due to different levels of ground shaking is developed. A computer program, DAMSTAT, is developed to automate the calculation steps for the proposed methodology. A description, listing, and application of this computer program is presented.

SHOCK

(Also see Nos. 1127, 1239)

79-1143
Child Restraint Systems Testing. Appendix
A.R. Bayer, Jr. and B.S. Peterson
Engrg. Test Facility, National Highway Traffic Safety Admin., East Liberty, OH, Rept. No. DOT/HS-803 409, 250 pp (May 1978)
PB-288 262/9GA

Key Words: Seat belts, Collision research (automotive), Experimental data

Headform impact tests and sled tests are conducted on child restraint systems, designed for use in motor vehicles, to evaluate their safety performance characteristics.

79-1144
Theoretical Investigation of Loads on Buried Structures. Volume 1. Results of Discussion
R.R. Robinson
IIT Research Inst. Chicago, IL, Rept. No. IITRI-J6378-VOL-1, AFWL-TR-78-6-VOL-1, 234 pp (Aug 1978)
AD-A061 464/4GA

Key Words: Nuclear explosion effects, Simulation, Underground structures, Cylinders, Finite element technique

The objective of this project is to develop simplified techniques for determining loads on buried structures of cylindrical geometry subjected to severe dynamic airblast load environments. The data forming the basis for these design loads are derived from numerical, finite element analyses for a wide range of loading, soil, and structural parameters.

79-1145
Theoretical Investigation of Loads on Buried Structures. Volume II. Tables and Plots
R.R. Robinson
IIT Research Inst., Chicago, IL, Rept. No. IITRI-J6378-VOL-2, AFWL-TR-78-6-VOL-2, 596 pp (Aug 1978)
AD-A061 465/1GA

Key Words: Nuclear explosion effects, Simulation, Underground structures, Cylinders, Finite element technique

The objective of this project is to develop simplified techniques for determining loads on buried structures of cylindrical geometry subjected to severe dynamic airblast load environments. The data forming the basis for these design loads are derived from numerical, finite element analyses for a wide range of loading, soil, and structural parameters.

79-1146
Analysis of Two Decoupled Explosion Simulations
T.C. Bache and J.F. Masso
Systems Science and Software, La Jolla, CA, Rept. No. SSS-R-78-3627, 51 pp (Apr 1978)
AD-A061 006/3GA

Key Words: Nuclear explosion effects, Simulation, Ground motion

Two axisymmetric ground motion calculations are carried out by the applied theory, incorporated to simulate 25 kt decoupled nuclear explosions in mined cavities in salt. One cavity is spherical with a radius of 66 meters while the other is a 3/1 aspect ratio ellipsoid of revolution. Both have the same volume. Results of the two calculations are analyzed to determine the character of the teleseismic body and surface waves.

TRANSPORTATION

(Also see No. 1254)

79-1147
Controlling Road Traffic Noise
P.M. Nelson
Environment Div., Transport and Road Res. Lab., Noise Control Vib. Isolation, 9 (9), pp 363-367 (Nov/Dec 1978) 1 fig, 3 tables, 23 refs

Key Words: Motor vehicle noise, Traffic noise, Noise reduction

This article reviews the progress that has been made towards the development of procedures to control and reduce vehicle and traffic noise for existing and short term development and for long term planning. The role of research carried out at the Transport and Road Research Laboratory in determining suitable strategies is illustrated.

79-1148
Recent Developments in Heavy Commercial Vehicle Cab Noise
R.P. Lewis and J.F. Collins
Noise Control Vib. Isolation, 9 (9), p 383 (Nov/Dec 1978)

Key Words: Commercial transportation, Trucks, Noise reduction

This article is concerned with the application of well proven techniques to the reduction of cab noise to a level which at least equals that in other vehicles with a reputation for low noise levels.

PHENOMENOLOGY

DAMPING

(Also see Nos. 1135, 1136)

79-1149
Experimental Determination of Linear Damping Coefficients in Elastic Structures with Geometric Nonlinearity

G. Maymon
School of Aerospace Engrg., Georgia Inst. of Tech., Atlanta, GA 30332, Israel J. Tech., 16 (1&2), pp 64-69 (1978) 5 figs, 9 refs

Key Words: Elastic media, Damping coefficients, Periodic excitation

A new formulation for the damping coefficient of a nonlinear elastic system is presented. The formulation which is based on the Duffing equation points out three methods by which experimental determination of the damping coefficient by steady state excitation can be achieved. Basically, these methods are based on the measurements of the jump points of the response curve of the system. Test results which are based on the outline methods are presented and compared with transient test results.

79-1150

Viscous Damper Qualification on Diesel Locomotive Engines - A Case History

H. Hershkowitz
Applications Engrg., Scientific-Atlanta, Inc., Noise Control Vib. Isolation, 10 (1), pp 15-19 (Jan 1979) 8 figs, 4 refs

Key Words: Viscous damping, Diesel engines

This paper presents some results of a study in measuring the performance characteristics of viscous vibration dampers that are used on diesel locomotive engines. The objective of this study is to develop a method for determining the quality of dampers in an operating environment on the engine.

ELASTIC

79-1151

Dynamical Response of an Infinite Elastic Medium to Axisymmetric Lineloads in a Cylindrical Cavity

A.P. Jensen
Ph.D. Thesis, Stanford Univ., 108 pp (1978)
UM 7905878

Key Words: Elastic media, Cavity-containing media, Dynamic response

This study of the disturbances in an extended isotropic, homogeneous, and linear elastic medium with a cylindrical cavity assumes an axisymmetric lineload which varies in time like a Heaviside step-function. With this formulation a broad class of problems is covered; both the static Flament's problem, Lamb's problem when the radius of the hole goes to infinity, and also the case with an arbitrary load varying along the axis. The general problem is formulated and a formal solution in form of double transforms of the displacements is obtained. The long-time static case and the case of infinite radius, the first order approximation to surface waves is obtained on integral form. The integration is performed numerically.

79-1152

Harmonic Wave Propagation in a Periodically Layered, Infinite Elastic Body: Plane Strain, Analytical Results

T.J. Delph, G. Herrmann, and R.K. Kaul
Div. of Appl. Mech., Dept. of Mech. Engrg., Stanford Univ., Stanford, CA 94305, J. Appl. Mech., Trans. ASME, 46 (1), pp 113-119 (Mar 1979) 4 figs, 11 refs

Key Words: Wave propagation, Elastic media

The problem of harmonic wave propagation in an unbounded, periodically layered elastic body in a state of plane strain is examined. The asymptotic behavior of the spectrum for large values of the wave numbers is investigated.

FLUID

(Also see Nos. 1184, 1185, 1192)

79-1153

Large-Amplitude Transient Motion of Two-Dimensional Floating Bodies

R.B. Chapman
David W. Taylor Naval Ship Res. and Dev. Center, Bethesda, MD, J. Ship Res., 23 (1), pp 20-31 (Mar 1979) 18 figs

Key Words: Floating bodies, Transient excitation, Numerical analysis

A numerical method is presented for solving the transient two-dimensional flow induced by the motion of a floating body. The flow is divided into two parts: the wave field and the impulsive flow required to satisfy the instantaneous body boundary condition. The wave field is represented by a

finite sum of harmonics. Two modes of body motion are discussed – a captive mode and a free mode. In the former case, the body motion is specified, and in the latter, it is calculated from the initial conditions and the inertial properties of the body. Two examples are given -- water entry of a wedge in the captive mode and motion of a perturbed floating body in the free mode.

79-1154

Scattering of Waves by Two-Dimensional Circular Obstacles in Finite Water Depths

R.A. Naftzger and S.K. Chakrabarti
Marine Res. and Dev., Chicago Bridge & Iron Co., Plainfield, IL, J. Ship Res., 23 (1), pp 32-42 (Mar 1979) 14 figs, 19 refs

Key Words: Water waves, Submerged structures, Cylinders, Boundary value problems

The wave forces on a fixed two-dimensional object submerged in water of finite depth are obtained under the assumptions of linear wave theory. The far-field characteristics of the wave interaction with the object are also examined. The boundary-value problem for the wave potential is formulated in terms of Green's theorem, and the resulting integral equation is solved numerically. Results for a submerged and half-submerged circular cylinder and a bottom-seated half cylinder are presented. In the limiting case of infinite depth the numerical results compare quite well with known solutions.

79-1155

Across-Flow Response Due to Vortex Shedding: Isolated Circular Cylindrical Structures in Wind or Gas Flows

Engrg. Sciences Data Unit, Ltd., London, UK, Rept. No. ISBN-0-85679-229-2, 59 pp (Oct 1978)
ESDU-78006

Key Words: Cylindrical bodies, Vortex-induced vibration, Fluid-induced excitation

The purpose of this item is to provide data in a convenient form for estimating the maximum oscillation amplitudes induced by vortex shedding on flexible structures and the critical flow speeds at which they occur. This information is also important in the fatigue analysis of a structure. Only isolated structures of circular cross section are treated in this Data Item.

79-1156

Some Observations of Four Current Subjects Related to Aeroelastic Stability

H. Ashley
Stanford Univ., Stanford, CA, Israel J. Tech., 16 (1&2), pp 3-22 (1978) 14 figs, 1 table, 63 refs

Key Words: Aeroelasticity, Dynamic stability, Aircraft wings, Wind turbines

A table is presented summarizing the author's views on some currently solved vs. partially unsolved problems related to aeroelastic stability. Selected entries in the table are reviewed. The four current subjects are: the prediction of linearized unsteady aerodynamic loads due to arbitrary motions of streamlined shapes; nonlinear unsteady aerodynamics for the transonic régime; and recent discoveries regarding the aeroelastic stability of large-aspect-ratio wings and wind turbines.

SOIL

79-1157

Effects of Radiation Damping on Vibration of a Shallow-Buried Rectangular Structure

G.L. Wojcik and J. Isenberg
Weidlinger Associates, Menlo Park, CA, Rept. No. R-7818, DNA-4600F, AD-E300 370, 90 pp (Apr 1978)
AD-A061 442/0GA

Key Words: Underground structures, Interaction: soil-structure, Finite element technique

Radiation damping from shallow-buried structures of rectangular cross-section is analyzed by means of an elastic, finite element model. Implications of including a viscous damping mechanism to simulate radiation damping in nonlinear single-degree-of-freedom models of the roof slab are examined. An exact analysis of a cylindrical elastic, plane strain section in an infinite elastic domain is performed.

EXPERIMENTATION

DIAGNOSTICS

79-1158

Acoustic Emission Monitoring of TIG Welding

R.S. Williams and C.F. zur Lippe

Lynchburg Research Ctr., Babcock and Wilcox Co., Lynchburg, VA, Rept. No. AMMRC-TR-78-34, 122 pp (July 1978)
AD-A061 045/1GA

Key Words: Diagnostic techniques, Acoustic techniques, Nondestructive testing, Welding joints

The purpose of this program is to apply acoustic emission technology to TIG welding of D6AC panels typical of those proposed for improved roll and weld fabrication of rocket motor cases. Test panels are welded to simulate longitudinal, circumferential, and intersection welds. These welds are monitored in-process using a source location acoustic emission system. After welding, conventional nondestructive and destructive examinations of these welds are performed. Finally, a conceptual design for a prototype AE weld monitor system is presented.

79-1159
Machinery Health Monitoring - Some Common Defects
R. Monk
Noise Control Vib. Isolation, 10 (1), pp 24-26 (Jan 1979) 7 figs

Key Words: Diagnostic techniques

Many frequently occurring machining problems which may be catastrophic unless detected in time are briefly discussed. They are defective rolling element bearings, oil whip on plain journal bearings, resonant excitation due to oil whip, and the rub condition at sub-rotational frequencies.

79-1160
Acoustic Emission from a Brief Crack Propagation Event
J.D. Achenbach and J.G. Harris
The Technological Inst., Northwestern Univ., Evanston, IL 60201, J. Appl. Mech., Trans. ASME, 46 (1), pp 107-112 (Mar 1979) 7 figs, 10 refs

Key Words: Crack propagation, Sound generation

Acoustic emissions produced by elementary processes of deformation and fracture at a crack edge are investigated on the basis of elastodynamic ray theory. Wavefront motions generated by an arbitrary distribution of climbing edge dislocations emanating from the tip of a semi-infinite crack in an unbounded linearly elastic solid are analyzed. These wavefront results are expressed in terms of emission coefficients which govern the variation with angle, and phase functions which govern the intensity of the wavefront signals. Explicit expressions for the emission coefficients are presented. Such effects as focusing, finite duration of the propagation event, and finite dimensions of the crack are briefly discussed.

79-1161
Diffraction of SH-Waves by an Edge Crack
S.K. Datta
Dept. of Mech. Engrg., Univ. of Colorado, Boulder, CO 80309, J. Appl. Mech., Trans. ASME, 46 (1), pp 101-106 (Mar 1979) 5 figs, 9 refs

Key Words: Secondary waves, Wave diffraction, Cracked media

Diffraction of an antiplane shear (SH-) wave by an edge crack in a semi-infinite elastic medium is studied. Asymptotic expansions for the scattered field both near and far from the crack are obtained for the case when the wavelength is large compared to the length of the crack. Near-field expansion is used to compute the dynamic stress-intensity factor at the tip of the crack. Also, the far-field expansion gives the scattered displacement amplitude, which is useful in ultrasonic nondestructive evaluation.

EQUIPMENT

79-1162
Method of and Apparatus for Non-Destructively Testing Concrete
M. Gutierrez and P.F. Enger
Dept. of the Interior, Washington, D.C., Rept. No. PB-288 619/0, 25 pp (Aug 1978)
PAT-APPL-931 069/GA

Key Words: Testing techniques, Nondestructive tests, Concretes, Test equipment, Vibration meters

The patent application relates generally to methods of, and apparatus for, testing concrete, and more particularly, to a method of and apparatus for non-destructively testing concrete by impacting the concrete and monitoring induced vibrational energy using a triangular array of transducers equispaced from the point of impact.

FACILITIES

79-1163

Jet Engine Testing - A Total System Approach

J.A. Hill

Powerplant Systems Div., Marconi Avionics Ltd., Noise Control Vib. Isolation, 10 (1), pp 27-28 (Jan 1979) 3 figs

Key Words: Test facilities, Noise control

Noise control in modular jet engine test facilities is discussed.

79-1164

The Benefits of Diesel Engine Noise Research

A. Rogers

Combustion and Noise, Perkins Engines Group, Noise Control Vib. Isolation, 9 (9), pp 388-390 (Nov/Dec 1978) 5 figs

Key Words: Diesel engines, Noise generation, Test facilities

Diesel engine noise research performed at Perkins Engines is described.

79-1165

The Use of Sound Absorbing Walls to Reduce Dynamic Interference in Wind Tunnels

D.G. Mabey

Royal Aircraft Establishment, Bedford, UK, 41 pp (Mar 30, 1978)

N79-13062

Key Words: Wind tunnel tests, Acoustic resonance, Acoustic absorption, Dynamic excitation

A scheme for reducing dynamic interference at subsonic and transonic speeds is tested in two wind tunnels. Two types of dynamic interference are considered: excitation of unwanted acoustic resonances within the working section, and flow unsteadiness.

INSTRUMENTATION

79-1166

Frequency Analog Measuring Technique: Linear Displacement Pick-up by Means of a Vibrating String (Frequenzanaloge Messtechnik: Lineare Wegumformung mit Hilfe der schwingenden Saite)

D. Bouts

INIL, Boumerdes Alger, Algeria, Techn. Messen, 46 (1), pp 33-35 (Jan 1979) 5 figs, 1 ref

(In German)

Key Words: Measuring instruments, Vibratory techniques

The design of a frequency analog displacement transducer based on a vibrating string was described earlier. In this paper a new simplified transducer with only one moving part is introduced. An application for pressure measurements is discussed.

79-1167

Which Meter?

B. Gracey

Gracey & Assoc., Noise Control Vib. Isolation, 10 (1), pp 8-9 (Jan 1979) 1 table

Key Words: Measuring instruments, Sound level meters

A table listing some sound level instruments is constructed. It lists 62 instruments and 25 classifications and a scoring system with a maximum scoring potential of 131 points.

79-1168

Response of Wide Dynamic Range Integrating Sound Level Meters to Impulsive Sounds

I. Campbell

Computer Engrg. Ltd., Noise Control Vib. Isolation, 10 (1), pp 12-13 (Jan 1979) 3 figs

Key Words: Sound level meters

The general noise level is varying relatively slowly and has impulses superimposed on it; hence the dynamic range requirement is the product of these two separate conditions - level and impulse. There are two problems that have to be overcome in order to produce a general purpose L_{eq} meter –

the integrating sound level meter: flexibility and cost. The squaring circuit in the detector is presented with the same problem as the noise average meters: that of handling very large dynamic ranges.

79-1169
A Solid State Digital Data Recorder for Monitoring Automotive Crash Environments
R.J. Wolf
Kaman Sciences Corp., Colorado Springs, CO, Rept. No. K-78-24U(R), DOT-HS-803 666, 73 pp (Feb 1978)
PB-289 039/0GA

Key Words: Collision research (automotive), Test equipment, Recording instruments

A solid state digital data recorder is developed for use in monitoring automotive impact environments. The recorder is designed to be a general purpose, on board data acquisition system. The functions of reading and storing data by the recorder channels are determined by a single, common control module. A nine channel system is evaluated via a pneumatic shock machine, vibration testing on a shaker, 30 mph sled simulated vehicle-barrier impacts, and 30 mph vehicle barrier impacts.

79-1170
Superconducting Accelerometer Using Niobium-on-Sapphire rf Resonator
D.G. Blair
Dept. of Physics and Astronomy, Louisiana State Univ., Baton Rouge, LA 70803, Rev. Scientific Instr., 50 (3), pp 286-291 (Mar 1979) 5 figs, 18 refs

Key Words: Accelerometers

An accelerometer is described which uses a rf niobium-on-sapphire resonator as its sensor element. The accelerometer uses a magnetically levitated spool as a test mass and the spool modulates the inductance of the resonator at the external rf excitation frequency. The system noise sources are analyzed and possible improvements are discussed.

79-1171
True-Integrating Environmental Noise Monitor and Sound Exposure Level Meter. Volume 1. User's Guide
P.D. Schomer, A.J. Averbuch, and M.W. Weisberg
Construction Engrg. Res. Lab. (Army), Champaign, IL, Rept. No. CERL-TR-N-41, 23 pp (May 1978)
AD-A060 958/6GA

Key Words: Noise measurement, Measuring instruments

This report summarizes desirable features and factors in environmental noise monitors, in general, and in particular, monitors which measure the impulsive noise created by military sources. Particular emphasis is placed on the need to have a true-integrating detector to properly measure these impulsive sources. Based on these needs, a noise monitor has been designed and constructed. This report summarizes the operations and components of this monitoring unit. Volume II describes the construction, parts lists, layouts, and schematics of the monitoring unit.

79-1172
Measurement of Torsional Vibrations by a Non-Contacting Laser Probe System
Noise Control Vib. Isolation, 10 (1), p 23 (Jan 1979) 3 figs

Key Words: Measuring instruments, Lasers, Torsional vibrations

A laser-Doppler system for measuring torsional vibrations of rotating shafts is described. There is no restriction on the measuring position provided a line of sight is available for the laser beam. Normally, a good machined surface has sufficiently good reflection for the reflected laser light to be detected but, for very poor surfaces, reflective paint can be applied. A further advantage of the laser vibration measuring system is that its frequency response is flat and linear over a wide frequency range.

TECHNIQUES
(Also see Nos. 1119, 1131, 1162)

79-1173
Techniques for the Measurement of Acoustic Impedance of Asphalt
P.A. Mansbach and C.I. Holmer
Acoustical Engrg. Div., National Engrg. Lab. (NBS), Washington, D.C., Rept. No. NBSIR-78-1541, 94 pp (Oct 1978)
PB-287 936/9GA

Key Words: Measurement techniques, Acoustic impedance, Pavements, Acoustic measuring instruments

Five techniques are used in an attempt to measure the very high acoustic impedance of an asphalt surface. These techniques are: Impedance Tube, Pure-Tone Traverse, Pulse-Echo, Broad-Band Cross-Correlation, and Direct Accelerometer Measurement. These techniques are described and evaluated in some detail, and the results of the measurements are presented. Effects of the finite test surface impedance on source emission measurements are discussed.

79-1174

Limitations and Corrections in Measuring Dynamic Characteristics of Structural Systems

P.L. Walter

Ph.D. Thesis, Arizona State Univ., 252 pp (1978)
UM 7904988

Key Words: Measurement techniques, Dynamic properties, Structural response

This work deals with limitations encountered in measuring the dynamic characteristics of structural systems. Structural loading and response are measured by transducers possessing multiple resonant frequencies in their transfer function. Data recorded during nuclear effects simulation testing on structures are analyzed. Methods to improve the recorded data are described which can be implemented on a frequency selective basis during the measurement process.

79-1175

On the Impact Torsional Test by Means of a Dropped Bar

A. Chatani and A. Hojo
Faculty of Tech., Kanazawa Univ., Kanazawa, Japan,
Bull. JSME, 22 (163), pp 8-15 (Jan 1979) 16 figs, 3 tables, 16 refs

Key Words: Hopkinson's bar technique, Impact tests, Torsional response

In this paper the impact torsional stress of a circular bar supported horizontally and subjected to impact torsion when a cross pin attached to the end of it was struck by a dropped bar is described. An impact torsional testing device of Hopkinson bar type is designed and experiments are carried out with thin tubular specimens of a low carbon steel.

79-1176

A Study of Multiple-Shaker Modal Survey Testing

W.L. Hallauer, Jr.
Dept. of Aerospace and Ocean Engrg., Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, Rept. No. NASA-CR-157890, 44 pp (1978)
N79-10447

Key Words: Shakers, Modal tests, Vibration tests, Testing techniques

The principal objective is to examine and to assess the practical value of a method of multiple-shaker sinusoidal modal vibration testing known as Asher's method. Numerical studies which simulate the application of Asher's method and a unique experimental implementation of the method are completed. Another objective of the research is to develop and to demonstrate with numerical simulation a quantitative method for determining from transfer function data the number of dominant modes of vibration in sinusoidal structural response.

COMPONENTS

ABSORBERS

(See No. 1126)

SHAFTS

79-1177

Analysis and Design of Advanced Stern-Tube Bearing Systems

O. Pinkus
Mechanical Technology, Inc., Latham, NY, Rept. No. MTI-78TR98, MA-RD-79009, 160 pp (Oct 1978)
PB-288 843/6GA

Key Words: Rotor-bearing systems, Shafts, Bearings, Marine propellers, Computer programs

This report covers the development of new bearing concepts aimed at improving the conditions and reliability of stern-tube bearing operation. An analysis of shaft bending and bearing performance is translated into appropriate computer programs which provide comprehensive solutions to the shaft-bearing problem. Two new bearing arrangements, one

rigid and one self-aligning, both containing new bearing designs, are proposed which provide system optimization for each particular vessel.

BEAMS, STRINGS, RODS, BARS

(Also see No. 1136)

79-1178

Eigensolutions for Coupled Thermoelastic Vibrations of Timoshenko Beams

R.C. Shieh
Transportation Branch, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, J. Appl. Mech., Trans. ASME, 46 (1), pp 169-174 (Mar 1979) 1 fig, 13 refs

Key Words: Beams, Free vibration, Timoshenko theories

A general solution procedure, together with two special case solutions, for the free-vibration boundary-value problem of a circular or rectangular cross-section Timoshenko beam under general mechanical boundary conditions and the thermal boundary conditons that follow the Newton surface heat transfer law is presented within the context of coupled linear thermoelasticity.

79-1179

The Initial-Boundary Value Problem of the Transverse Vibrations of a Homogeneous Beam Clamped at One End and Infinitely Long in One Direction. I

N. Ortner
Univ. Innsbruck, Technikerstrasse 13, A-6020 Innsbruck, Austria, Bull. Acad. Polon. Sci., Ser. Sci. Tech., 26 (8-9), pp 389-401, 723-735 (1978)

Key Words: Beams, Flexural vibration, Boundary value problems

In this paper an explicit solution of the mixed problem, with non-vanishing initial data, of the transverse vibrations of a beam infinitely long in one direction clamped at one end is derived.

79-1180

The Initial-Boundary Value Problem of the Transverse Vibrations of a Homogeneous Beam Clamped at One End and Infinitely Long in One Direction. II

N. Ortner
Univ. Innsbruck, Technikerstrasse 13, A-6020 Innsbruck, Austria, Bull. Acad. Polon. Sci., Ser. Sci. Tech., 26 (8-9), pp 403-415, 737-749 (1978) 12 refs

Key Words: Beams, Flexural vibration, Boundary value problems

In this part the problem presented in part I is continued to be solved. A definite integral which plays an important role is explicitly computed by reduction to a Dirichlet problem for the Laplace operator in the quarter-plane. By formal application of the Laplace transform, the Green function for an infinitely long, elastically supported beam clamped at one end is obtained.

79-1181

Elastic-Plastic Dynamic Analysis of Structures Using Known Elastic Solutions

S.C. Liu and T.H. Lin
Mechanics and Structures Dept., Univ. of California, Los Angeles, CA, Intl. J. Earthquake Engr. Struc. Dynam., 7 (2), pp 147-159 (1979) 9 figs, 14 refs

Key Words: Beams, Plates, Elastoplastic properties, Numerical analysis

A numerical method is shown to analyze the dynamic elastic-plastic responses of those structures with known elastic solutions. The displacement caused by a unit load applied at another point at zero time, called the dynamic influence coefficient, is calculated from the known elastic solutions. From the incremental load including that caused by the incremental plastic strain, the displacement vs time of the structure is obtained. This method is applied to simply supported beams with binlinear stress-strain relations with different strain-hardening rates and to a simply supported elastic-ideally plastic rectangular plate. This procedure can be extended to structures with no available known analytical elastic solutions. For these structures, the elastic solutions can be obtained by the finite element method.

79-1182

A Steadily Moving Load on an Elastic Beam Resting on a Tensionless Winkler Foundation

J. Choros and G.G. Adams

Association of American Railroads, Chicago, IL 60616, J. Appl. Mech., Trans. ASME, 46 (1), pp 175-180 (Mar 1979) 12 figs, 13 refs

Key Words: Beams, Elastic foundations, Winkler foundations, Moving loads, Periodic response, Bernoulli-Euler method

An infinitely long Euler-Bernoulli beam resting on a tensionless Winkler foundation is considered. Steady-state solutions are obtained for a downward directed concentrated force moving with constant speed. First, the critical load necessary to initiate separation of the beam from the foundation is determined for a range of speed. Closed-form solutions of the differential equations are obtained in terms of local coordinate systems. The extent and location of the noncontact regions, as well as the corresponding beam deflections, are then determined for a range of force and speed.

79-1183

Forced Torsional Vibration of an Elastic Circular Rod on an Elastic Half Space and on an Elastic Stratum

H.S. Paul and K. Sridharan

Dept. of Mathematics, Indian Inst. of Tech., Madras-600 036, India, J. Acoust. Soc. Amer., 65 (2), pp 391-398 (Feb 1979) 6 figs, 2 tables, 10 refs

Key Words: Circular bars, Rods, Torsional vibration, Forced vibration, Vibration damping

The forced torsional vibration of an elastic circular rod, whose lower end is attached to the free surface of an elastic half space or stratum, while the upper end is subjected to a periodic torque is investigated. Expression for the driving point impedance is obtained for low-frequency oscillations using specific boundary conditions at the interface. Resonance curves are plotted which exhibit the damping of the vibrations of the rod due to dissipation of waves to infinity.

79-1184

Dynamics of Slender Tapered Beams with Internal or External Axial Flow. Part 1: Theory

M.J. Hannoyer and M.P. Paidoussis

Dept. of Mech. Engrg., McGill Univ., Montreal, Quebec, Canada H3A 2K6, J. Appl. Mech., Trans. ASME, 46 (1), pp 45-51 (Mar 1979) 7 figs, 18 refs

Key Words: Cantilever beams, Beams, Cylinders, Tubes, Variable cross section, Fluid-induced excitation, Equations of motion

This paper develops a general theory for the dynamics of slender, nonuniform axisymmetric beams subjected to either internal or external flow, or to both simultaneously. Typical solutions of the equations of motion are presented for cantilevered conical beams in external flow and for beams with a conical internal flow passage. The effect of several parameters is investigated.

79-1185

Dynamics of Slender Tapered Beams with Internal or External Axial Flow. Part 2: Experiments

M.J. Hannoyer and M.P. Paidoussis

Dept. of Mech. Engrg., McGill Univ., Montreal, Quebec, Canada H3A 2K6, J. Appl. Mech., Trans. ASME, 46 (1), pp 52-57 (Mar 1979) 5 figs, 10 refs

Key Words: Cantilever beams, Beams, Tubes, Cylinders, Variable cross section, Fluid-induced excitation, Experimental data

This paper describes the experimental program which was conducted in parallel with the theoretical investigation presented in Part 1 of this study. Experiments are conducted in a special water tunnel with silicone rubber cantilevers which, in the case of external flow, are truncated cones, the free ends of which are streamlined; in the case of internal flow the beams are tubular, conical inside, and either conical or cylindrical outside, immersed either in still air or water. Experiments are also conducted with uniform tubular cylinders, and some with simultaneous internal and external axial flow. Qualitatively these experiments support theoretical predictions very well. The critical conditions for the various fluid-elastic instabilities which these systems can develop are measured and compared with theory.

79-1186

The Dynamics of Reinforced Coarse Nets Using a Finite Element Analysis

J.M. Shanks and C.M. Leech

Dept. of Mech. Engrg., Univ. of Manchester Inst. of Science and Tech., Manchester, UK, Intl. J. Mech. Sci., 21 (2), pp 131-138 (1979) 6 figs, 1 table, 10 refs

Key Words: Strings, Energy absorption, Finite element technique

The dynamics of prestressed orthogonal coarse nets are investigated using a finite element analysis; the effects of various cross weave reinforcements are considered. Element overstress, arrest times and net penetration are numerically predicted for various impact velocities and the data is collapsed to yield two empirical fits of use in net design.

79-1187
Stability of Faired Underwater Towing Cables
S. Nair and G. Hegemier
Illinois Inst. of Tech., Chicago, IL, J. Hydronautics, 13 (1), pp 20-27 (Jan 1979) 3 figs, 9 refs

Key Words: Dynamic stability, Towing cables, Cables, Underwater structures

The dynamic stability of faired, heterogeneous underwater cables subject to small perturbations from a planar towing configuration is considered. Sufficient conditions for freedom from flutter and divergence are obtained using the velocity component strip theory. These conditions are given in the form of constraints on the locations of shear center, center of tension, hydrodynamic center, and center of gravity of the cable cross section.

BEARINGS

(Also see No. 1177)

79-1188
Spherical Bearing
W.N. Myers and L.A. Hein
NASA Marshall Space Flight Ctr., Huntsville, AL, 8 pp (Aug 8, 1978)
U.S. PATENT-4 105 261

Key Words: Bearings, Ball bearings, Vibration excitation

A spherical bearing, including an inner ball with an opening for receiving a shaft and a spherical outer surface, is described. Features of the bearing include: a circular outer race including a plurality of circumferentially spaced sections extending around the inner ball for snugly receiving the inner ball; and a groove extending circumferentially around the race producing a thin wall portion which permits the opposed side portions to flex relative to the ball for maximizing the physical contact between the inner surface of the race and the spherical outer surface of the ball.

BLADES

79-1189
Dynamic Stability of a Two-Blade Rotor
C.T. Tran
European Space Agency, Paris, France, ESA-TT-491, pp 63-96 (Aug 1978) (Engl. transl. from La Rech. Aerospatiale, Bull. Bimestriel, Paris, no. 1978-1, pp 25-40 (Jan-Feb 1978))
N79-11999

Key Words: Dynamic stability, Rotor blades

An analytical method is presented in which Lagrange equations are simplified to a system of ordinary differential equations with constant coefficients in an evaluation of the dynamic stability of a two blade rotor at high tip speeds with negligible aerodynamic disturbance. Attention is given to the parameterization of the divergence velocity.

79-1190
The Effect of Root Flexibility on the Torsional Vibration of Uniform Section Blades
V.K. Singh and S. Rawtani
Dept. of Appl. Mech., Maulana Azad College of Tech., Bhopal (M.P.), India, Intl. J. Mech. Sci., 21 (3), pp 141-147 (1979) 5 figs, 2 tables, 16 refs

Key Words: Turbomachinery blades, Blades, Torsional vibration

The present paper deals with the effect of root flexibility on the torsional vibrations. Solution of the governing differential equation with appropriate boundary conditions is obtained. The proper non-dimensional root flexibility and frequency parameters are derived. The effect on the first three torsional natural frequencies and the corresponding mode shapes is studied for the complete spectrum of root flexibility ranging from a clamped to a free root. An empirical formula is suggested for the value of the correction factor by which the fixed root frequency may be multiplied to obtain the flexible root frequency.

CONTROLS

79-1191
An Experimental-Numerical Concept for Determination of the Transfer Functions of Hydraulic Servo-

actuators (Bestimmung der dynamischen Aktuatorübertragungsfunktionen mit Hilfe eines experimentell-rechnerischen Verfahrens)
R. Freymann
Institut f. Aeroelastik der Deutschen Forschungs- und Versuchsanstalt f. Luft- und Raumfahrt DFVLR, Bunsenstrasse 10, 3400 Göttingen, Germany, Z. Flugwiss, 2 (6), pp 405-416 (1978) 13 figs, 13 refs (In German)

Key Words: Hydraulic servomechanisms, Flutter

The complex non-linear and frequency dependent impedances of the hydraulic actuators must be known if hydraulic surface actuators are to be considered in a flutter analysis. An experimental-numerical method for determination of these transfer functions is given with special regard to non-linear and preload effects.

CYLINDERS

(Also see Nos. 1154, 1184, 1185, 1201)

79-1192
Computation of the Hydrodynamic Forces Induced by General Vibration of Cylinders
W.C. Webster
Dept. of Naval Architecture, College of Engrg., Univ. of California, Berkeley, CA, J. Ship Res., 23 (1), pp 9-19 (Mar 1979) 12 figs, 11 refs

Key Words: Cylinders, Hydrodynamic excitation, Finite element technique, Ships

The hydrodynamic pressures created by the arbitrary deformation around the girth of a two-dimensional section are computed in a form suitable for finite-element structural analysis. The computations are based on the panel method developed for determining the hydrodynamic forces on rigid sections. In this method the section is approximated by straight-line segments on each of which source singularities of constant strength are distributed. The source strengths are determined by matching the kinematic boundary condition at the center of each panel. The method is extended to treat nonrigid-body deformations on an infinite cylinder, including deformations which are also periodically varying in the longitudinal direction.

79-1193
Vortex-Excited Unsteady Forces on Resonantly Vibrating, Bluff Structures
O.M. Griffin
Naval Research Lab., Washington, D.C., Rept. No. NRL-MR-3820, AD-E000 231, 43 pp (Aug 1978) AD-A060 710/1GA

Key Words: Cylinders, Vortex-induced vibration, Mathematical models

This report considers recent experimental findings pertaining to the vortex-excited oscillations of bluff cylinders, and compares various approaches to measuring the resultant fluid forces. As one example, measurements of the structural damping and crossflow response amplitudes are made for several systems over a representative range of wind tunnel flow speeds. The fluid dynamic damping or reaction in-phase with the cylinder's velocity is also measured for different incident flow speeds over a range which includes the locking-on of the vortex shedding to the resonant cylinder vibrations. A mathematical model is proposed in connection with these measurements. In a second approach, the fluid forces are measured on a cylinder which is forced to oscillate in water at different frequencies and crossflow amplitudes over a range of incident flow speeds.

DUCTS

(See No. 1106)

FRAMES, ARCHES

79-1194
A Micropolar Continuum Model for Vibrating Grid Frameworks
K. Kanatani
Dept. of Mathematical Engrg. and Instrumentation Physics, Faculty of Engrg., Univ. of Tokyo, Tokyo, Japan, Intl. J. Engr. Sci., 17 (4), pp 409-418 (1979) 5 figs, 10 refs

Key Words: Grids (beam grids), Frames, Approximation methods

A principle of converting a discrete system of grid frameworks to an equivalent micropolar continuum model is given with the degree of approximation taken into consideration. A micropolar continuum is then defined in the form of

higher order extension. In order to supplement defects of previous theories, a complex-valued micropolar continuum model is constructed for grid frameworks vibrating with an arbitrary frequency by means of the variational principle related to the average energy of the system. The accuracy of solutions is also investigated.

GEARS

(Also see No. 1246)

79-1195

A Study on the Unstable Vibration Phenomena of a Reduction Gear System, Including the Lightly Loaded Journal Bearings, for a Marine Steam Turbine

T. Yamada and J. Mitsui

Tamano Research Lab., Mitsui Engrg. & Shipbuilding Co., Ltd., Bull. JSME, 22 (163), pp 98-106 (Jan 1979) 12 figs, 15 refs

Key Words: Gears, Journal bearings, Turbine components, Vibration response

The unstable vibration phenomena (different from ordinary phenomena such as oil whirl, oil whip and so forth) are observed in the locked train type reduction gear system of a marine steam turbine while it is subjected to running conditions with no load. The unstable vibration phenomena are assumed to be due to the self-exciting vibration system which is caused by both the oil film characteristics of the journal bearings which support the reduction gears and the torsional vibration system.

MECHANICAL

79-1196

The Driveline as a Source of Vibration

R.G. Joyner

Universal Joint Div., Dana Co., SAE 780778, 16 pp, 17 figs, 1 ref

Key Words: Driveline vibrations, Unbalanced mass response, Torsional excitation, Inertial forces

This paper explains and gives corrective procedures for driveline vibrations caused by unbalance, torsional excitation, inertia excitation and secondary couple effect. The influence of the driveline on the system bending resonance of the engine-transmission package is also explained.

MEMBRANES, FILMS, AND WEBS

(See No. 1120)

PIPES AND TUBES

79-1197

Seismic Response Behavior of Buried Pipelines

L.R.-L. Wang and K.-M. Cheng

T.Y. Lin International, San Francisco, CA 94133, J. Pressure Vessel Tech., Trans. ASME, 101 (1), pp 21-30 (Feb 1979) 19 figs, 21 refs

Key Words: Pipelines, Underground structures, Seismic response, Earthquake damage, Interaction: soil-structure

A simplified quasi-static seismic deformation analysis neglecting the dynamic terms for buried pipelines subjected to earthquake motions in the axial direction is proposed. The analysis involves the solution of a system of static equilibrium equations of a pipeline which consists of rigid pipe-segments and flexible joint springs. Using this model, parametric studies involving soil-pipe interaction parameters, time delay of the traveling seismic waves, soil-variations along the pipeline, end conditions and variation of the seismic wave form are performed.

79-1198

A Shell Model of a Buried Pipe in a Seismic Environment

G.E. Muleski, T. Ariman, and C.P. Aumen

Univ. of Notre Dame, Notre Dame, IN 46556, J. Pressure Vessel Tech., Trans. ASME, 101 (1), pp 44-50 (Feb 1979) 5 figs, 20 refs

Key Words: Piping systems, Underground structures, Cylindrical shells, Seismic excitation

In this paper a thin circular cylindrical shell model in a resisting soil medium is used for a buried pipe. The coupled equilibrium equations arising from this model are modified to yield three decoupled equations which simplify the analy-

sis. An application for a long buried pipe is presented and the results are discussed and compared with those of the beam model.

79-1199

Some Aspects of Seismic Risk Analysis of Underground Lifeline Systems

M. Shinozuka, S. Takada, and H. Ishikawa
Columbia Univ., New York, NY, J. Pressure Vessel Tech., Trans. ASME, 101 (1), pp 31-43 (Feb 1979) 15 figs, 12 tables, 42 refs

Key Words: Piping systems, Pipelines, Cables (ropes), Underground structures, Seismic design, Earthquake damage

The current state of the art of the seismic risk analysis for the underground lifeline systems, particularly for the water transmission network system, is reviewed. An emphasis in the review is placed on the analysis of major causes of system damages and on the procedures of the seismic design decision analysis unique to the underground lifeline systems. A methodology of the seismic risk analysis is then developed and an example analysis performed for a simplified version of the water transmission system in the city of Los Angeles indicating each step of the analysis and each assumption used. The example analysis is carried through to the point where a sample of physically damaged network systems are simulated by means of a Monte Carlo technique.

79-1200

Dynamic Seismic Analysis of Long Segmented Lifelines

I. Nelson and P. Weidlinger
Weidlinger Associates, Consulting Engineers, New York, NY, J. Pressure Vessel Tech., Trans. ASME, 101 (1), pp 10-20 (Feb 1979) 9 figs, 12 refs

Key Words: Pipes (tubes), Pipe joints, Seismic response, Interference response spectra

A long, straight, segmented pipe, with each link attached to the ground via a spring and dashpot is subjected to incoherent ground motion caused by a phase delay. The equations governing the axial response of the system are developed. Modal decomposition is used and closed form expressions are given for the natural frequencies and mode shapes. Examples are given showing the center joint displacement time history when the lifeline is subjected to earthquake loading.

79-1201

Dynamics of Flexible Cylinders in Axisymmetrically Confined Axial Flow

M.P. Paidoussis and M.J. Pettigrew
Dept. of Mech. Engrg., McGill Univ., Montreal, Quebec, Canada, J. Appl. Mech., Trans. ASME, 46 (1), pp 37-44 (Mar 1979) 7 figs, 1 table, 13 refs

Key Words: Cylinders, Tubes, Fluid-induced excitation, Heat exchangers

This paper describes experiments in which flexible cylinders placed centrally within a narrow cylindrical flow channel are subjected to axial flow. The dynamical behavior of such cylinders, either cantilevered or supported at both ends, is described, both in liquid and in simulated two-phase flows; the effect of several parameters, such as the annular confinement is investigated. The experimental observations are compared to a theoretical model for the dynamics of such systems.

79-1202

Nonlinear Stability Analysis of a Two-Dimensional Model of an Elastic Tube Conveying a Compressible Flow

Y. Matsuzaki and Y.-C. Fung
National Aerospace Lab., Jindaiji, Chofu, Tokyo, Japan, J. Appl. Mech., Trans. ASME, 46 (1), pp 31-36 (Mar 1979) 5 figs, 14 refs

Key Words: Tubes, Fluid-filled containers, Fluid-induced excitation, Flutter, Viscous damping

This paper examines the dynamic behavior of a two-dimensional channel whose upper and lower walls deform symmetrically with respect to the center line of the channel. Unsteady fluid dynamic forces acting on the internal wall are analytically evaluated on the basis of a linearized compressible potential flow theory. The effects of distributed springs outside the channel and an internal pressure on the stability characteristics are studied by considering small disturbances about flat and buckled equilibrium configurations of the wall.

PLATES AND SHELLS

(Also see No. 1198)

79-1203

Acoustic Radiation and Scattering from Elastic Structures

D.T. Wilton

Admiralty Underwater Weapons Establishment, Portland, UK, Rept. No. AUWE-TN-574/78, 34 pp (Apr 1978)
AD-A060 840/6GA

Key Words: Shells, Elastic analysis, Interface: structure-fluid, Finite element technique

This report presents a numerical technique for the linear dynamic analysis of a finite elastic structure immersed in an infinite homogeneous acoustic medium. A finite element analysis of the structure is matched at the structure-fluid interface with an integral equation representation of the exterior acoustic field, leading to a coupled system of equations which may be cast in either acoustic or structural form.

79-1204

Seismic Behavior of Tall Liquid Storage Tanks

A. Niwa

Ph.D. Thesis, Univ. of California, Berkeley, 319 pp (1978)
UM 7904560

Key Words: Cylindrical shells, Tanks (containers), Seismic response, Experimental data

The results are discussed of an experimental program in which a scaled model of a ground supported, thin-shell, cylindrical liquid storage tank with height greater than radius was subjected to simulated earthquake excitation. Analytical investigations on out-of-round shell deformation of cylindrical tanks are also presented. Methods, model, and facilities utilized in the experimental evaluation of the seismic behavior of tall tanks are described. Principal results of this experimental investigation are presented in the form of a critical evaluation of current seismic design practice. Development of an analytical procedure illustrating a possible correlative mechanism between the initial geometric eccentricity in the cross-section of the tank model and the out-of-round shell deformation is described in detail.

79-1205

Transient Response of Two Fluid-Coupled Cylindrical Elastic Shells to an Incident Pressure Pulse

H. Huang

Naval Research Lab., Washington, D.C., Rept. No. NRL-MR-3821, AD-E000 232, 40 pp (Aug 1978)
AD-A060 711/9GA

Key Words: Cylindrical shells, Coupled systems, Fluid-induced excitation, Transient response

The transient response of a system of two initially concentric circular cylindrical elastic shells coupled by an ideal fluid and impinged by an incident plane pressure pulse is studied. The classical techniques of separation of variable and Laplace transforms are employed for simultaneously solving the wave equations governing the fluid motions and the shell equations of motion. The transformed solutions are arranged in such a manner that their inverse transforms can be accurately calculated by solving a set of Volterra integral equations in the time domain. A sample calculation of shell response is performed and results are compared to the case in which the outer shell is absent.

79-1206

Correlation Between Vibration and Buckling of Stiffened Cylindrical Shells Under External Pressure and Combined Loading

H. Abramovich and J. Singer

Dept. of Aeronautical Engrg., Technion-Israel Inst. of Tech., Haifa, Israel, Israel J. Tech., 16 (1&2), pp 34-44 (1978) 12 figs, 2 tables, 21 refs

Key Words: Cylindrical shells, Boundary value problems, Correlation technique, Axial force

A vibration correlation technique for definition of the boundary conditions of stringer-stiffened shells, developed earlier for axial compression loading, is extended to the case of external pressure and axial compression. The technique consists of an experimental determination of the natural frequencies, in vibration modes that resemble the buckling modes of a loaded shell, and assessment of the equivalent elastic restraints which represent the boundary conditions by comparison with theoretically predicted frequencies. With these assessed restraints obtained from nondestructive tests, the buckling pressures or loads are calculated. Four steel shells and six aluminum shells are tested in a special test rig. Experimental interaction curves for combinations of external pressure and axial compression are obtained. The effects of repeated buckling in stiffened shells are also studied in relation to interaction curves.

79-1207

Isolation of the Resonant Component in Acoustic Scattering From Fluid-Loaded Elastic Spherical Shells

J.D. Murphy, J. George, A. Nagl, and H. Überall

3709 Merlin Way, Annandale, VA 22003, J. Acoust.

Soc. Amer., 65 (2), pp 368-373 (Feb 1979) 7 figs, 19 refs

Key Words: Spherical shells, Submerged structures, Fluid-filled containers, Acoustic scattering, Resonant response

The process of resonance excitation of a spherical, fluid (or gas) filled elastic shell imbedded in another fluid, in the course of scattering of a plane incident sound wave from the shell, using the recently developed formalism of resonance scattering theory is investigated. Numerical studies are performed for air-filled aluminum shells immersed in water. A physical explanation of the existence of the shell resonances is presented in terms of elastic circumferential waves created on the shell during the scattering process.

79-1208
Axisymmetric Flexural Vibrations of a Thick Free Circular Plate

J.R. Hutchinson
Dept. of Civil Engrg., Univ. of California, Davis, CA 95616, J. Appl. Mech., Trans. ASME, 46 (1), pp 139-144 (Mar 1979) 13 figs, 10 refs

Key Words: Circular plates, Plates, Flexural vibrations, Natural frequencies, Mode shapes, Transverse shear deformation effects, Rotatory inertia effects

A series solution of the general three-dimensional equations of linear elasticity is used to find accurate natural frequencies and mode shapes for the flexural vibrations of thick free circular plates. The approximate solution for thick plates, which includes shear and rotary inertia effects, is compared with the accurate series solution.

79-1209
Vibrations and Bucklings of a Circular Plate with Various Constraints on Its Annular Circle

K. Okazaki, Y. Hirano, K. Nagaya, and K. Arakawa
Faculty of Engrg., Yamagata Univ., Yonezawa, Japan, Bull. JSME, 22 (163), pp 31-40 (Jan 1979) 8 figs, 11 refs

Key Words: Circular plates, Eigenvalue problems, Flexural vibration, Buckling

This paper deals with the flexural vibration and the buckling of a circular plate with various constraints on its annular circle. The constrained conditions are treated by means of the weighted residual methods when they are partially different on the circle. The reaction force on the constrained parts may be considered an apparent external force, and then the inhomogeneous differential equation is solved. Numerical results are given and the eigenvalue problems are discussed.

79-1210
Membrane Mode Solutions for Impulsively Loaded Circular Plates

P.S. Symonds and T. Wierzbicki
Div. of Engrg., Brown Univ., Providence, RI 02912, J. Appl. Mech., Trans. ASME, 46 (1), pp 58-64 (Mar 1979) 9 figs, 24 refs

Key Words: Circular plates, Mode approximation technique

Large deflections of a clamped circular plate subjected to axially symmetric impulsive loading are obtained by means of the mode approximation technique. The mode shapes and accelerations are determined by equations assuming simple membrane action. The predicted deflections and response times are compared with quantities measured in recently published experiments on plates of steel, titanium, and lead.

79-1211
Transient Interaction of a Circular Plate and a Fluid Medium

J.W. Berglund
Theoretical Analysis Div., Civil Engrg. Research Facility, The University of New Mexico, Albuquerque, NM 87131, J. Appl. Mech., Trans. ASME, 46 (1), pp 26-30 (Mar 1979) 5 figs, 15 refs

Key Words: Circular plates, Interaction: structure-fluid, Transient response

The transient dynamic response of an elastic circular plate subjected to a suddenly applied pressure is determined for several edge boundary conditions. The plate boundary is attached to a semi-infinite, radially rigid tube which is filled with an acoustic fluid, and pressure is applied to the in-vacuo side of the plate. The transient solution is determined by using a technique in which the plate is subjected to a periodic pressure function constructed of appropriately signed and time-shifted Heaviside step functions, and by relying on a physical mechanism which returns the plate and fluid near the plate to an unconstrained state of rest between

pulses. The plate response is presented for a number of radius-to-thickness ratios and edge boundary conditions when interacting with water. Comparisons are also made with solutions obtained using a plane wave approximation to the fluid field.

79-1212

Resonant Excitation of a Spinning, Nutating Plate

J.W. Klahs, Jr. and J.H. Ginsberg

Structural Dynamics Research Corp., Cincinnati, OH, J. Appl. Mech., Trans. ASME, 46 (1), pp 132-138 (Mar 1979) 6 figs, 17 refs

Key Words: Plates, Rotating structures

The equations of motion governing the three-dimensional finite-amplitude response of a plate in arbitrary space motion are derived. A general method of solution for such problems is demonstrated in an example involving a simply supported rectangular plate spinning about an axis parallel to an edge and nutating through a small angle. The method involves an asymptotic expansion using the derivative expansion version of the method of multiple time scales, in conjunction with the Galerkin method. A critical spin rate leading to the loss of stability in divergence is determined.

RINGS

79-1213

Accurate Nonlinear Equations and a Perturbation Solution for the Free Vibrations of a Circular Elastic Ring

J.G. Simmonds

Dept. of Appl. Mathematics and Computer Science, Univ. of Virginia, Charlottesville, VA 22901, J. Appl. Mech., Trans. ASME, 46 (1), pp 156-160 (Mar 1979) 1 fig, 13 refs

Key Words: Rings, Free vibration, Perturbation theory

A set of gemoetrically nonlinear equations is derived for the plane motion of an elastically homogeneous circular ring.

SPRINGS

79-1214

Plate Spring Mechanism with Constant Negative Stiffness

J. Van Eijk and J.F. Dijksman

Univ. of Colombo, Sri Lanka, Mech. Mach. Theory, 14 (1), pp 1-9 (1979) 6 figs, 5 refs

Key Words: Springs, Stiffness coefficients

In this paper a mechanism with negative spring stiffness is discussed, the action of which is based on the instability of the second order buckling state of a flat plate spring clamped at both ends.

79-1215

Optimal Design of Helical Springs for Minimum Weight by Geometric Programming

G.K. Agrawal

Government Engrg. College, Ujjian, India, ASME Paper No. 78-WA/DE-1

Key Words: Helical springs, Minimum weight design

Geometric programming is applied to solve a design optimization problem for minimum weight helical compression springs. An explicit solution of the optimization problem is obtained and applied to a numerical example. This paper describes the application of geometric programming, a recent method of optimization to the problem of optimum design of a helical compression spring.

STRUCTURAL

(Also see Nos. 1131, 1142)

79-1216

Structural Walls in Earthquake-Resistant Buildings. Dynamic Analysis of Isolated Structural Walls. Input Motions

A.T. Derecho, L.E. Fugelso, and M. Fintel

Construction Tech. Labs., Portland Cement Assn., Skokie, IL, Rept. No. PCA-R/D-SER-1586, NSF/RA-780200, 59 pp (Dec 1977)

PB-288 028/4GA

Key Words: Earthquake resistant structures, Buildings, Walls, Seismic response

A characterization of input motions for use in dynamic analysis is given in terms of intensity, duration and frequency content. Different measures of intensity are examined. Accelerograms are classified with respect to frequency content as peaking or broad band, depending upon the character of the associated 5%-damped relative velocity response spectra.

TIRES

79-1217
Basic Studies of Automobile Tire Noise
J. Pope
Ph.D. Thesis, Stanford Univ., 281 pp (1978)
UM 7905957

Key Words: Automobile noise, Automobile tires, Experimental data, Noise measurement

The sound radiated by rolling automobile tires is studied in a specially constructed semi-anechoic acoustic laboratory. Most work is with steel-belted radial-ply tires having special hand-cut treads of simple design. A single commercial-design tire of similar size and radial construction plus several hand-cut, bias-ply tires are also investigated. These tires are run on a roadwheel-type tire testing machine under realistic highway speed and load conditions. Sound level and power spectrum measurements are made to characterize the resulting sound fields. Additional time and frequency domain analyses are performed to gain insight into the mechanisms of tire noise generation. Superposition techniques are investigated as a rational approach to sound cancellation by appropriate phasing of tread features. Differences between tire noise measured in the laboratory and that reported in the literature for observations adjacent to a highway, i.e., the relationship of lab noise to highway noise, are considered briefly.

79-1218
Theoretical Model of the Truck Tire Vibration Sound Mechanism
R.F. Keltie
Ph.D. Thesis, North Carolina State Univ. at Raleigh, 111 pp (1978)
UM 7905492

Key Words: Truck tires, Sound propagation, Mathematical models, Tire characteristics

A theoretical model is developed to describe the sound radiation by the surface vibration of in-service truck tires and to investigate the effects of tire parameters on the sound field. The tire carcass is modeled as an infinitely long thin circular cylindrical shell, incomplete in the meridional direction to account for the presence of the rim. The effects of damping and the inflation pressure are included in the model. The normal displacement, velocity, and acceleration are determined using Flügge's thin shell theory for an arbitrary fluctuating load acting on the shell model. The material properties of the model are chosen so that the phase velocities and decay rates of the model closely match those obtained through experiments with actual tires.

SYSTEMS

ABSORBER

79-1219
Vehicular Impact Absorption System
A.C. Knoell and A.H. Wilson
NASA, Pasadena Office, CA, 5 pp (Oct 3, 1978)
Sponsored by NASA
U.S. PATENT-4 118 014

Key Words: Energy absorption, Bumpers, Automobiles

An improved vehicular impact absorption system characterized by a plurality of aligned crash cushions of substantially cubic configuration is described. Each consists of a plurality of voided aluminum beverage cans arranged in substantial parallelism within a plurality of superimposed tiers and a covering envelope formed of metal hardware cloth. A plurality of cables is extended through the cushions in substantial parallelism with an axis of alignment for the cushions adapted to be anchored at each of the opposite end thereof.

79-1220
Optimum Vibration Absorbers for Linear Damped Systems
S.E. Randall, D.M. Halsted, III, and D.L. Taylor
Sperry New Holland, New Holland, PA, ASME Paper No. 78-WA/DE-22

Key Words: Vibration absorption (equipment) Damped structures, Graphic methods

This paper presents computational graphs that determine the optimal linear vibration absorber for linear damped primary systems. The main system damping ratio and the mass ratio examined over the range 0 to 0.50 and 0.01 to 0.40, respectively, are considered as independent parameters. The remaining nondimensional parameters are optimized using numerical methods based on a minimum maximum amplitude criteria.

79-1221

Lateral Compression of Tubes and Tube-Systems with Side Constraints

T.Y. Reddy and S.R. Reid

Engrg. Dept., Univ. of Cambridge, Trumpington St., Cambridge CB2 1PZ, UK, Intl. J. Mech. Sci., 21 (3), pp 187-199 (1979) 7 figs, 15 refs

Key Words: Tubes, Energy absorption

The quasi-static diametral compression of a tube constrained so that its horizontal diameter cannot increase is considered both theoretically and experimentally. The relationship between the behavior of a single tube and a nest of tubes is examined experimentally and the role of closed system in energy absorption is discussed.

NOISE REDUCTION

(Also see No. 1223)

79-1222

Potential Effectiveness of Barriers Toward Reducing Highway Noise Exposure on a National Scale

K.J. Plotkin and V.K. Kohli

Wyle Labs., Wyle Research, Arlington, VA, Rept. No. WR-78-9, EPA/550/9-78/309, 26 pp (July 1978) PB-288 109/2GA

Key Words: Noise barriers, Highway transportation

Calculations are performed to assess the potential effectiveness of barriers toward reducing noise exposure from the federal-aid highway system. Noise exposure, in terms of the numbers of people exposed to Ldn greater than 60, 65, 70, and 75 dB, from the primary federal aid system is computed for present traffic flow and projected traffic through the year 2000. Reductions in noise exposure are computed for several scenarios of constructing barriers along urban interstate highways.

79-1223

Attenuate Noise from Gas Turbines and Diesel Engines

R.F. Werkmeister

American Air Filter Co., Power 123 (3), pp 80-82 (Mar 1979) 5 figs, 1 table

Key Words: Gas turbines, Diesel engines, Noise reduction

Three noise sources which must be considered in the design of a noise control system for gas turbines are evaluated. They are: inlet, casing, and exhaust noise. A table shows the calculational procedure required for the selection of an exhaust silencer. Similar calculations are made for the filter, plenum walls, inlet silencer, enclosure walls, exhaust stack, and ventilation system.

79-1224

Initial Results of a Porous Plug Nozzle for Supersonic Jet Noise Suppression

L. Maestrello

NASA Langley Research Ctr., Hampton, VA, Rept. No. NASA-TM-78802, 21 pp (Nov 1978) N79-13820

Key Words: Jet noise, Nozzles, Noise reduction

Some tests are made on a porous plug type noise suppressor. Some initial results on the aeroacoustic performance of a model porous plug type jet noise suppressor are presented. Included are shadowgraph pictures of the flow exhausting from the porous plug nozzle with the comparable acoustic far-field spectra and cross correlations which illustrate the benefits of the test device.

ACTIVE ISOLATION

79-1225

Are Active Suspensions Really Necessary?

D.C. Karnopp

Univ. of California, Davis, CA, ASME Paper No. 78-WA/DE-12

Key Words: Suspension systems (vehicles), Active isolation

Optimum vibration isolation systems or vehicle suspension characteristics are derived using the methods of optimal control theory. Some basic configurations are examined.

AIRCRAFT

(Also see No. 1156)

79-1226

Vibration and Flutter Investigations of Aircraft with Special Nonlinear Structural Properties (Schwingungs- und Flatteranalyse von Flugzeugen mit besonderen nichtlinearen Struktureigenschaften)

O. Sensburg and B. Schoen

Messerschmitt-Bölkow-Blohm GmbH, Postfach 8011-60, 8000 München 80, Germany, Z. Flugwiss, 2 (6), pp 395-404 (1978) 18 figs, 11 refs

Key Words: Aircraft, Wing stores, Flutter, Mathematical models

This paper describes an analytical procedure to treat the influence of nonlinear structural properties – especially in the support mechanism of heavy wing stores – on the vibration and flutter behavior of modern combat aircraft. To get an approximation of the different vibration behavior of nonlinear structures, parameter variations using linearized limit values for the nonlinear elements are used to perform vibration and flutter calculations using conventional calculation methods. A more accurate analysis method is developed in conjunction with a test model using a simplified mathematical model with nonlinear properties by applying the treatment of harmonic linearization.

79-1227

Analysis of Noise in U.S. Army Aircraft

A.J. Brouns and R.A. Ely

Vought Corp. Advanced Tech. Center, Inc., Dallas, TX, Rept. No. ATC-94100/8CR-41, USAAVRAD-COM-TR-76-1746-F, 240 pp (Nov 1978)
AD-A061 351/3GA

Key Words: Aircraft noise, Noise measurement, Noise reduction

Tape recordings are made of acoustical and electrical noise in the crew compartments and on the interphone lines of 7 models of U.S. Army aircraft, during flight operations. The data is analyzed to determine noise and speech levels in the communication channel, especially at crew members' ears. Calculations are performed to estimate hearing damage risk and estimate the intelligibility of speech. The purpose of the project is to identify harmful noise levels and sources in the communication channel and to make recommendations for reducing such noise.

79-1228

Technology Status of Jet Noise Suppression Concepts for Advanced Supersonic Transports

W.T. Rowe, E.S. Johnson, and R.A. McKinnon

McDonnell Douglas Corp., Long Beach, CA, J. Aircraft, 16 (2), pp 95-101 (Feb 1979) 21 figs, 2 tables, 9 refs

Key Words: Aircraft noise, Supersonic aircraft, Noise reduction

In conducting technology studies for advanced supersonic transports, Douglas Aircraft Company of the McDonnell Douglas Corporation has found that the constraints of community noise dictate the engine cycle selection and nozzle design, and significantly affect the overall airplane configuration design. The definition of engine cycles, provisions for jet exhaust noise suppression, levels of suppression achievable, and the impact of each possible combination on overall airplane performance and technical risk are examined. This paper presents one aircraft manufacturer's views on the technology status of three of the most promising exhaust nozzle designs meeting the noise constraints: the coannular, the coannular with plug, and the retractable mechanical suppressor. Each type is defined along with predicted operational characteristics. Theoretical and actual test performance, for both thrust loss and noise suppression, are summarized. Each of these three nozzles is combined with an appropriate engine, and is sized and integrated into a baseline Mach 2.2 supersonic transport to evaluate range performance. The current status of performance for the various suppression concepts is summarized.

79-1229

A Theoretical Investigation of Noise Reduction Through the Cylindrical Fuselage of a Twin-Engine, Propeller-Driven Aircraft

R.B. Bhat and J.S. Mixson

NASA Langley Research Ctr., Hampton, VA, Rept. No. NASA-TP-1325; L-12225, 47 pp (Dec 1978)
N79-13821

Key Words: Aircraft noise, Noise generation, Noise reduction, Cylindrical shells, Mathematical models

Interior noise in the fuselage of a twin-engine, propeller-driven aircraft with two propellers rotating in opposite directions is studied analytically. The fuselage is modeled as a stiffened cylindrical shell with simply supported ends, and the effects of stringers and frames are averaged over the shell surface. An approximate mathematical model of the propeller noise excitation is formulated which includes some of the propeller noise characteristics such as sweeping pressure waves around the sidewalls due to propeller rotation and the localized nature of the excitation with the highest levels near the propeller plane. Results are presented in the form of noise reduction. The influence of propeller noise characteristics on the noise reduction is studied.

BRIDGES

79-1230

Seismic Response of Long Curved Bridge Structures: Experimental Model Studies

D. Williams and W. Godden

URS/John A. Blume & Assoc., Engineers, San Francisco, CA, Intl. J. Earthquake Engr. Struc. Dynam., 7 (2), pp 107-128 (1979) 17 figs, 8 refs

Sponsored by the U.S. Dept. of Transportation

Key Words: Bridges, Seismic response, Model testing

This paper presents the results of a shaking table study conducted on the seismic behavior of curved reinforced concrete bridge structures of the type used in highway interchanges. A series of representational 1/30th scale models is constructed in microconcrete to study the effects of both linear and non-linear dynamic behavior, the non-linearity including sliding and impacting at the expansion joints and ductility in the columns. Each model is subjected to a series of increasingly severe simulated earthquakes in the longitudinal and transverse directions, both with and without the vertical component. Response data are recorded in the form of selected displacement time-histories. The paper concludes with general observations on the seismic behavior of long-span long-period curved bridges, and emphasizes the sensitivity of this behavior to the location and design of the joints.

79-1231

Theoretical and Experimental Dynamic Behaviour of a Curved Model Bridge Structure

K. Kawashima and J. Penzien

Public Works Research Inst., Ministry of Construction, Japan, Intl. J. Earthquake Engr. Struc. Dynam., 7 (2), pp 129-145 (1979) 15 figs, 10 refs

Key Words: Bridges, Seismic response, Model testing

Correlations between analytical and experimental seismic responses of a curved model bridge structure, which was constructed to have the same features as a typical full-scale high curved highway bridge structure, are presented. Dynamic behavior and seismic response of the experimental bridge model are examined with particular emphasis on the discontinuous behavior of expansion joints. Modeling of Coulomb type friction with slippages and impacting at the expansion joints is described. Correlations of displacement response of the bridge model carried out for three seismic excitations are presented. Parameter studies conducted to assist in the interpretation of correlation results are presented and the characteristics of the dynamic behavior of the bridge model are discussed.

BUILDING

(Also see Nos. 1113, 1126, 1141)

79-1232

Methodology for Mitigation of Seismic Hazards in Existing Unreinforced Masonry Buildings. Phase 1

S.B. Barnes, A.W. Johnson, and C.W. Pinkham

Barnes (S.B.) and Assoc., Los Angeles, CA, Rept. No. NSF/RA-780132, 69 pp (Mar 31, 1978)

PB-287 478/2GA

Key Words: Buildings, Masonry, Earthquake resistant structures, Seismic response

Unreinforced masonry buildings are studied in order to determine appropriate methods to deal with hazard mitigation and to study methods of retrofit so that design methods can be established. These design methods are devised with consideration of the particular structural conditions of unreinforced masonry construction, their earthquake response, the seismicity of the particular location, and the economics of retrofit. Phase 1 studies the state-of-the-art of hazard mitigation and retrofit. An outline of the design methodology is established and each item in the methodology is discussed. A set of suggested criteria are proposed. Finally, a summary of these further study items is included so that the work to be performed in Phase 2 can be identified.

79-1233

Earthquake-Resistant Reinforced Concrete Building Construction. Volume 1. Organization and Final Recommendations

V.V. Bertero and S.A. Mahin

Univ. Extension, California Univ., Berkeley, CA, Rept. No. NSF/RA-780303, 121 pp (June 1978)

PB-288 995/4GA

Key Words: Buildings, Reinforced concrete, Seismic design, Earthquake resistant structures

This workshop provides a means for the exchange of information related to the state-of-the-art and state-of-the-practice in the design and construction of seismic-resistant reinforced concrete buildings, to evaluate current progress, and to establish research needs and priorities for future work. Specific objectives are to: evaluate current knowledge and practice in the planning, design, and construction of earthquake-resistant reinforced concrete buildings; review the objectives and scope of existing research programs and discuss their findings to provide feedback to researchers; examine needs and priorities for immediate, as well as long-range, research required to remove gaps in current knowledge and to improve current practice; and improve communication and cooperation (at both the national and international levels) between research and professional organizations, as well as between different research groups. In Volume 1, the final recommendations of the workshop form the main portion of the text. Four appendices follow, containing the program, the list of participants, the list of working groups, and a research directory.

79-1234

Earthquake-Resistant Reinforced Concrete Building Construction. Volume II. Technical Papers

V.V. Bertero and S.A. Mahin

Univ. Extension, California Univ., Berkeley, CA, Rept. No. NSF/RA-780304, 1004 pp (June 1978)

PB-288 996/2GA

Key Words: Buildings, Reinforced concrete, Seismic design, Earthquake resistant structures

This workshop provides a means for the exchange of information related to the state-of-the-art and state-of-the-practice in the design and construction of seismic-resistant reinforced concrete buildings, to evaluate current progress, and to establish research needs and priorities for future work. Volumes 2 and 3 comprise the technical reports and papers that were presented. Topic areas in Volume 2 include: an overview of the state-of-the-practice in earthquake-resistant reinforced concrete building construction; user needs; mechanical characteristics and performance of reinforced and prestressed concrete materials under seismic conditions; reinforced and prestressed concrete structural systems; and methods of structural analysis.

79-1235

Earthquake-Resistant Reinforced Concrete Building Construction. Volume III. Technical Papers

V.V. Bertero and S.A. Mahin

Univ. Extension, California Univ., Berkeley, CA, Rept. No. NSF/RA-780305, 923 pp (July 1978)

PB-288 997/0GA

Key Words: Buildings, Reinforced concrete, Seismic design, Earthquake resistant structures

This workshop provides a means for the exchange of information related to the state-of-the-art and state-of-the-practice in the design and construction of seismic-resistant reinforced concrete buildings, to evaluate current progress, and to establish research needs and priorities for future work. Volumes 2 and 3 comprise the technical reports and papers that were presented. Topic areas in Volume 3 include: design methods and experimental and analytical investigations related to the earthquake-resistant reinforced concrete building construction of moment-resisting frames; design methods and experimental and analytical investigations related to the earthquake-resistant reinforced concrete building construction of frame-wall structures; foundations and retaining structures; experimental investigations of real buildings, models of complete buildings, and large subassemblages of buildings; and design methods and experimental and analytical investigations related to the earthquake-resistant reinforced concrete building construction of prestressed and prefabricated structures.

79-1236

Material and Dimensional Properties of an Eleven-Story Reinforced Concrete Building

R.A. Gardiner and D.S. Hatcher

Dept. of Civil Engrg., Washington Univ., St. Louis, MO, Rept. No. RR-52, NSF/RA-780316, 107 pp (Aug 1978)

PB-288 891/5GA

Key Words: Buildings, Reinforced concrete, Earthquake-resistant structures, Experimental data

Full-scale destructive testing of an eleven-story reinforced concrete structure is conducted. Objectives are to investigate

the in-situ structural dimensions and material properties, to determine the dynamic characteristics of the structure by small amplitude shaking tests, and to observe the structural damage and the degradation of the dynamic characteristics due to large amplitude shaking tests. This investigation concerns only the study of the in-situ structural dimensions and material properties. The methods used in the determination of the strength of the materials in the structure and the results obtained are reported. Included are both the yield and ultimate strength of the reinforcing steel and the compressive strength of the concrete. An enumeration is provided of the variations of the structural dimensions from their specified values and the manner in which these variations were determined. The effect of all the above variations on the flexural strength of representative sections of members in the structure is shown.

79-1237

Envelopes of Maximum Seismic Response for a Partially Symmetric Single Storey Building Model

K.M. Dempsey and H.M. Irvine

Univ. of Auckland, Auckland, New Zealand, Intl. J. Earthquake Engr. Struc. Dynam., 7 (2), pp 161-180 (1979) 15 figs, 21 refs

Key Words: Buildings, Seismic response, Coupled response, Lateral response, Torsional response

An analysis is made of the coupled lateral-torsional response of a partially symmetric single-story building model to horizontal translatory earthquake excitation. The response of the model is assumed to be linearly elastic and viscously damped. In a preliminary analysis the equations of motion are solved using the modal analysis technique and the conditions necessary for full modal coupling are ascertained. Dimensionless forms of the equivalent static actions are evaluated as functions of two independent parameters. The final results are furnished by modified square root of the sum of the squares (SRSS) combination functions which take account of the spacing between the translational and torsional frequencies.

79-1238

Stochastic Seismic Response Analysis of Hysteretic Multi-Degree-of-Freedom Structures

Y. Wen

Univ. of Illinois, Urbana, IL, Intl. J. Earthquake Engr. Struc. Dynam., 7 (2), pp 181-191 (1979) 6 figs, 13 refs

Key Words: Multistory buildings, Multi-degree-of-freedom systems, Seismic response, Stochastic processes, Statistical analysis

The purpose of this paper is to present a practical analytical-empirical method for a multi-degree-of-freedom (MDF) yielding system. The method is based on a substitute structure (SS) concept in which the SS parameters are determined from empirical results of single-degree-of-freedom systems, i.e., each element in the system is replaced by a linear counterpart with ductility-dependent stiffness and damping. Based on a linear random vibration response analysis, the statistics of the maximum response (ductility) of each element are obtained by iteration. Numerical examples are given for multi-story buildings with deteriorating (reinforced concrete frame) or non-deteriorating (steel frame) restoring forces.

79-1239

The Transfer Function of Quarry Blast Noise and Vibration into Typical Residential Structures

G.W. Kamperman and M.A. Nicholson

Kamperman Associates, Inc., Downers Grove, IL, Rept. No. EPA/550/9-77/351, 150 pp (Feb 1977) PB-288 892/3GA

Key Words: Buildings, Blast effects, Mines (excavations), Vibration excitation, Noise generation

An experimental program is conducted to determine the transfer function of quarry blast noise and vibration into typical structures. Four distinct noise and vibration signals are produced inside nearby dwellings.

FOUNDATIONS AND EARTH

79-1240

An Investigation of the Dynamic Characteristics of an Earth Dam

A.M. Abdel-Ghaffar and R.F. Scott

Earthquake Engrg. Research Lab., California Inst. of Tech., Pasadena, CA, Rept. No. EERL-78-02, 200 pp (Aug 1978) PB-288 878/2GA

Key Words: Dams, Earthquake response

An investigation is made to analyze observations of the effect of two earthquakes on Santa Felicia Dam, a rolled-fill em-

bankment located in Southern California. The dam is 236.5 ft high and 1,275 ft long by 30 ft wide at the crest. The purpose of the investigation is to study the nonlinear behavior of the dam during the two earthquakes; to provide data on the in-plane dynamic shear moduli and damping factors for the materials of the dam during real earthquake conditions; and to compare these properties with those previously available from laboratory investigations.

HELICOPTERS

(Also see No. 1282)

79-1241

A Laboratory Study of the Subjective Response to Helicopter Blade-Slap Noise

K.P. Shepherd

Bionetics Corp., Hampton, VA, Rept. No. NASA-CR-158973, 21 pp (Dec 1978)

N79-13819

Key Words: Helicopter noise, Human response

The test stimuli recorded consist of 16 sounds, each presented at 4 peak noise levels. Two helicopters and a fixed-wing aircraft are used.

79-1242

A Static Acoustic Signature System for the Analysis of Dynamic Flight Information

D.J. Ramer

Army Armament Res. and Dev. Command, Aberdeen Proving Ground, MD, In: NASA Langley Res. Ctr., Helicopter Acoustics, Pts. 2, pp 535-544 (Aug 1978)

N79-10852

Key Words: Helicopters, Acoustic signatures

The Army family of helicopters is analyzed to measure the polar octave band acoustic signature in various modes of flight. A static array of calibrated microphones is used to simultaneously acquire the signature and differential times required to mathematically position the aircraft in space. The signature is reconstructed, mathematically normalized to a fixed radius around the aircraft.

79-1243

Annoyance Due to Simulated Blade-Slap Noise

C.A. Powell

NASA Langley Research Ctr., Hampton, VA, In: NASA Langley Res. Ctr., Helicopter Acoustics, Pt. 2, pp 463-477 (Aug 1978)

N79-10847

Key Words: Helicopter noise, Rotary wings, Noise generation

The effects of several characteristics of blade slap noise on annoyance response are studied. These characteristics or parameters are the sound pressure level of the continuous noise used to simulate helicopter broadband noise, the ratio of impulse peak to broadband noise or crest factor, the number of pressure excursions comprising an impulse event, the rise and fall time of the individual impulses, and the repetition frequency of the impulses. Analyses are conducted to determine the correlation between subjective response and various physical measures for the range of parameters studied.

79-1244

Annoyance of Helicopter Impulsive Noise

F. Dambra and A. Damongeot

Societe Nationale Industrielle Aerospatiale, Paris, France, In: NASA Langley Res. Ctr., Helicopter Acoustics, Pt. 2, pp 439-462 (Aug 1978)

N79-10846

Key Words: Helicopter noise, Human response

Psychoacoustic studies of helicopter impulsive noise are conducted in order to qualify additional annoyance due to this feature and to develop physical impulsiveness descriptors to develop inpulsivity correction methods. The currently proposed descriptors and methods of impulsiveness correction are compared using a multilinear regression analysis technique. The equipment necessary for data processing in order to apply the correction method is discussed.

79-1245

Helicopter Internal Noise Control: Three Case Histories

B.D. Edwards and C.R. Cox

Textron Bell Helicopter, Ft. Worth, TX, In: NASA Langley Res. Ctr., Helicopter Acoustics, Pt. 2, pp 639-656 (Aug 1978)

N79-10858

Key Words: Helicopter noise, Noise reduction, Engine mounts, Viscous damping

Case histories are described in which measurable improvements in the cabin noise environments of the Bell 214B, 206B, and 222 are realized. These case histories trace the noise control efforts followed in each vehicle. Among the design approaches considered, the addition of a fluid pulsation damper in a hydraulic system and the installation of elastomeric engine mounts are highlighted.

79-1246

Helicopter Internal Noise Reduction Research and Development Application to the SA 360 and SA 365 Dauphin

H.J. Marze and F. Dambra

Societe Nationale Industrielle Aerospatiale, Paris, France, In: NASA Langley Res. Ctr., Helicopter Acoustics, Pt. 2, pp 695-722 (Aug 1978)

N79-10861

Key Words: Helicopter noise, Noise reduction, Gear boxes

Noise sources inside helicopter cabins are considered with emphasis on the mechanisms of vibration generation inside the main gear box and mechanisms of transmission between source and cabin. The dynamic behavior of the main gear box components is examined in relation to the transfer of vibration energy to the structure. Soundproofing treatments installed and optimized include: an acoustic screen using the weight effect to isolate the passenger from the noise source; a damping treatment to limit the conversion of the vibratory energy into acoustic energy; and an absorbing treatment achieved either through Helmholtz resonators or through a glass wool blanket to limit the propagation of acoustic waves and the wave reflection effects in the cabin.

79-1247

A Practical Approach to Helicopter Internal Noise Prediction

L.S. Levine and J.J. DeFelice

Sikorsky Aircraft, Stratford, CT, In: NASA Langley Res. Ctr., Helicopter Acoustics, Pt. 2, pp 595-638 (Aug 1978)

N79-10857

Key Words: Helicopter noise, Noise prediction

A practical and well correlated procedure for predicting helicopter internal noise is presented. It accounts for the propagation of noise along multiple paths on an octave by octave basis. The method is applicable to conventional helicopters as well as other aircraft types, when the appropriate structural geometry, noise source strengths, and material acoustic properties are defined. A guide is provided for the prediction of various helicopter noise sources over a wide range of horsepower for use when measured data are not available. The method is applied to the prediction of the interior levels of the Civil Helicopter Research Aircraft (CHRA), both with and without soundproofing installed.

79-1248

Helicopter Cabin Noise: Methods of Source and Path Identification and Characterization

B.S. Murray and J.F. Wilby

Bolt Beranek and Newman, Inc., Cambridge, MA, In: NASA Langley Res. Ctr., Helicopter Acoustics, Pt. 2, pp 583-594 (Aug 1978)

N79-10856

Key Words: Helicopter noise, Noise source identification

Internal noise sources in a helicopter are considered. These include propulsion machinery, comprising engine and transmission, and turbulent boundary layer effects.

79-1249

The Cost of Applying Current Helicopter External Noise Reduction Methods While Maintaining Realistic Vehicle Performance

M.A. Bowes

Kaman Aerospace Corp., Bloomfield, CT, In: NASA Langley Res. Ctr., Helicopter Acoustics, Pt. 2, pp 563-582 (Aug 1978)

N79-10855

Key Words: Helicopter noise, Noise reduction

Analytical methods are developed and/or adopted for calculating helicopter component noise, and these methods are incorporated into a unified total vehicle noise calculation model. Analytical methods are also developed for calculating the effects of noise reduction methodology on helicopter design, performance, and cost. These methods are used to calculate changes in noise, design, performance, and cost due to the incorporation of engine and main rotor noise reduction methods.

79-1250

Design of Helicopter Rotors to Noise Constraints

E.G. Schaeffer and H. Sternfeld, Jr.

Boeing Vertol Co., Philadelphia, PA, In: NASA Langley Res. Ctr., Helicopter Acoustics, Pt. 2, pp 551-561 (Aug 1978)

N79-10854

Key Words: Helicopter rotors, Noise reduction

Results of the initial phase of a research project to study the design constraints on helicopter noise are presented. These include the calculation of nonimpulsive rotor harmonic and broadband hover noise spectra, over a wide range of rotor design variables and the sensitivity of perceived noise level (PNL) to changes in rotor design parameters.

79-1251

Gust Response and Its Alleviation for a Hingeless Helicopter Rotor in Cruising Flight

M. Yasue

Aeroelastic and Structures Res. Lab., Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. ASRL-TR-189-1, 182 pp (Sept 1978)

AD-A061 134/3GA

Key Words: Helicopter rotors, Rotary wings, Wind-induced excitation

The vertical gust response and its alleviation for hingeless helicopter rotor blades in cruising flight is studied theoretically and experimentally. An evaluation is performed of the effectiveness of torsional stiffness variation in conjunction with chordwise center-of-gravity shift in alleviating the blade flapping response to decrease the root bending moment. The theoretical analysis utilizes the equations of motion of hingeless rotor blades exposed to vertical gusts in forward flight for the flapping, lagging, and elastic and rigid pitch degrees of freedom. The equations include the effect of steady-state deflections in the trim conditions and various hingeless rotor configurations such as precone, droop and torque offset as well as chordwise center-of-gravity shift and aerodynamic center offset. The experimental program involves the wind tunnel tests of a five-foot diameter rotor subject to a sinusoidal waveform gust. Testing involves variation of the blade chordwise center-of-gravity location, the blade torsional stiffness, rotor advance ratio, and vertical gust frequency.

HUMAN

(Also see No. 1244)

79-1252

An Automobile Noise Annoyance Problem

J.C. Johnson

Applied Res. Lab., The Pennsylvania State Univ., P.O. Box 30, State College, PA 16801, Noise Control Engr., 12 (1), pp 26-30 (Jan-Feb 1979) 3 figs, 7 refs

Key Words: Motor vehicle noise, Noise tolerance, Human response

Criteria for acceptance or rejection of production units are established to correct the problem of noise originating in the power drive train. Causes and remedies for the unwanted noise are covered. A working example of an approach and solution to a noise annoyance problem, rather than the development of subjective rating schemes and analytical techniques, is provided.

79-1253

Developments in Ride Quality Criteria

D.G. Stephens

NASA Langley Research Ctr., Hampton, VA 23665, Noise Control Engr., 12 (1), pp 6-14 (Jan-Feb 1979) 15 figs, 1 table, 21 refs

Key Words: Ground vehicles, Ride dynamics, Human response, Transportation systems

The vibration and noise environment of air and surface vehicles, as well as the passenger's subjective response to such environmental stimuli, are determined from laboratory and field studies. Ongoing research aimed at the development of models for evaluating or specifying the ride of existing and/or future transportation systems is discussed. In addition, ride quality criteria/standards for vibration, noise, and combinations of these stimuli are presented.

79-1254

Low Frequency and Infrasonic Noise in Transportation

N. Broner

Dept. of Physics, Chelsea College, Univ. of London, London SW6 5PR, UK, Appl. Acoust., 11 (2), pp (Apr 1978)

Key Words: Traffic noise, Infrasonic frequencies, Human response

This paper describes the results of an experimental program in which infrasonic levels are established inside aircraft, ships, trains, and road vehicles.

79-1255

A Model for Predicting Human Discomfort Response to Combined Noise and Vertical Vibration

J.D. Leatherwood

Ph.D. Thesis, North Carolina State Univ. at Raleigh, 207 pp (1978)

UM 7905508

Key Words: Noise tolerance, Vibration tolerance, Human response

An experimental study is conducted to determine the effects of combined environmental noise and vibration upon human subjective discomfort response and to determine correction factors to a NASA ride comfort model that allows prediction of passenger discomfort response to the combined environment. The levels and frequency ranges of the noise and vibration stimuli used in this study are selected such that they approximated those encountered in various air and ground transportation systems. The factors consist of vibration frequency, vibration discomfort level, octave-band frequency, and noise level in dB(A) units. The stimuli are applied to the subjects through the use of a realistic ride comfort simulator (called the Passenger Ride Quality Apparatus) located at the Langley Research Center. Subjective discomfort ratings are obtained by use of a magnitude estimation procedure and are analyzed and interpreted by computation of an analysis of variance and selected post-hoc tests.

ISOLATION

(Also see No. 1225)

79-1256

Insertion Loss for Resilient Machine Mountings as Applied to Punch Power Presses

C. Bramberger and L. Ryden

Institutet for Verkstadsteknisk Forskning (The Swedish Institute of Production Engrg. Res.), Molndalsvagen 85, S-412 85, Goteborg, Sweden, Noise Control Engr., 12 (1), pp 15-19 (Jan-Feb 1979) 7 figs

Key Words: Machine foundations, Presses, Industrial facilities, Noise reduction

A study to determine the efficiency of resilient machine mountings is summarized. The study is restricted to punch power presses with a capacity of up to 2000 kN.

MECHANICAL

(Also see No. 1181)

79-1257

On the Dynamic Simulation of Large Nonlinear Mechanical Systems

R.J. Cipra

Ph.D. Thesis, The Univ. of Wisconsin-Madison, 120 pp (1978)

UM 7823054

Key Words: Dynamic response, Mechanical systems, Nonlinear systems, Simulation

An analytical technique is presented for determining the dynamic response of large complex nonlinear systems. The simulation technique is aimed at large problems for which a portion is nonlinear and which are responding to inputs in such a manner that a linear model is not adequate. The types of problems covered are those which require large amounts of numerical data for their model description, or for which it may be difficult to analytically derive the controlling equations of motion. A method of time integration for nonlinear differential equations is presented based upon the repetitive analytical (modal) solution of a set of equations linearized about the current operating position. The method incorporates a variable time step suited to the degree of nonlinearity and as shown in an example problem, gives comparable agreement in results with a Runge-Kutta numerical technique.

OFF-ROAD VEHICLES

79-1258

Influence of the Constructive Parameters of a Truck on the Wheel Load Differences in Off-Road Service (Einfluss der konstruktiven Parameter eines Lastkraftwagens auf die Radlastdifferenzen im Gelande)

H. Loop and K. Schubert

Neve Welt 16, 7917 Vöhringen, Germany, Automobiltech. Z., 81 (2), pp 49-53 (Feb 1979) 7 figs, 1 table, 6 refs
(In German)

Key Words: Trucks, Off-highway vehicles

Wheel load differences during a diagonal twisting of a two-axle truck are derived by means of a mathematical model. The calculations are performed on a digital computer and are used to determine the wheel traction available during off-road service without a locked differential. They also serve to assess the stresses on the chassis frame, springs, and control arms as a function of various vehicle design parameters. Special attention is given to the influence which torsional stiffness of frame, roll and tire spring rate at axles, static axle load distribution, and wheel track have on the load differences between the individual wheels when the vehicle is being twisted diagonally.

PUMPS, TURBINES, FANS, COMPRESSORS

(Also see No. 1156)

79-1259

Basic Research in Fan Source Noise: Inlet Distortion and Turbulence Noise

R.A. Kantola and R.E. Warren

Corporate Res. and Dev., General Electric Co., Schenectady, NY, Rept. No. NASA-CR-159451, 161 pp (Dec 1978)
N79-14875

Key Words: Fans, Noise source identification

A widely recognized problem in jet engine fan noise is the discrepancy between inflight and static tests. This discrepancy consists of blade passing frequency tones, caused by ingested turbulence that appear in the static tests but not in flight. To reduce the ingested distortions and turbulence in an anechoic chamber, a reverse cone inlet is used to guide the air into the fan. This inlet also has provisions for boundary layer suction and is used in conjunction with a turbulence control structure (TCS) to condition the air impinging on the fan. The program is successful in reducing the ingested turbulence, to the point where reductions in the acoustic power at blade passing frequency are as high as 18 db for subsonic tip speeds.

79-1260

Suggested Improvements in the Measurement of Pump Vibration for In-Service Inspection

M.C. Plummer

Transitek, Inc., Santa Clara, CA, ASME Paper No. 78-WA/NE-5

Key Words: Pumps, Nuclear power plants, Vibration measurement

In this paper it is recommended that the vibration measurements used for the in-service inspection of pumps in nuclear power plants be changed. The changes include replacing vibration displacement measurements by measurements of vibration velocity as a more sensitive indicator of machinery condition. It is recommended that absolute limits for vibration velocity be established for the acceptance of new pumps in nuclear power plant applications. The recommended changes are justified by relating the vibration velocity to alternating stress and fatigue of the pump materials.

79-1261

Analysis of Supersonic Stall Bending Flutter in Axial Flow Compressor by Actuator Disk Theory

J.J. Adamczyk

NASA Lewis Research Ctr., Cleveland, OH, Rept. No. NASA-TP-1245; E-9186, 58 pp (Nov 1978)
N79-13003

Key Words: Compressors, Blades, Rotors, Flutter

An analytical model is developed for predicting the onset of supersonic stall bending flutter in axial-flow compressors. The analysis is based on two-dimensional, compressible, unsteady actuator disk theory. It is applied to a rotor blade row by considering a cascade of airfoils. The effects of shock waves and flow separation are included in the model. Calculations show that the model predicts the onset, in an unshrouded rotor, of a bending flutter mode that exhibits many of the characteristics of supersonic stall bending flutter. The validity of the analysis for predicting this flutter mode is demonstrated.

RAIL

79-1262

Lateral Stability of Freight Cars with Axles Having Different Wheel Profiles and Asymmetric Loading

J.M. Tuten, E.H. Law, and N.K. Cooperrider

Dept. of Mech. Engrg., Clemson Univ., Clemson, SC, J. Engr. Indus., Trans. ASME, 101 (1), pp 1-16 (Feb 1979) 16 figs, 2 tables, 20 refs

Key Words: Lateral response, Railroad cars, Freight cars

Models capable of having different wheel profiles on the same axle as well as on different axles are developed to investigate the stability behavior. These models are formulated so that the effects on stability of asymmetric fore and aft loading conditions, as manifested through gravitational stiffness effects and creep coefficients, are examined.

79-1263

Selected Topics in Railroad Tank Car Safety Research. Volume 11. Test Plan for Accelerated Life Testing of Thermally Shielded Tank Cars

M.R. Johnson and O.J. Viergutz

IIT Research Inst., Chicago, IL, Rept. No. FRA/ORD-78/32-11, DOT-TSC-FRA-78-12-11, 72 pp (Aug 1978)

PB-289 254/5GA

Key Words: Railroad cars, Tank cars, Impact tests

A test plan for the accelerated life testing of thermally shielded tank cars is described. The test program is conducted at the DOT Transportation Test Center in Pueblo, Colorado. Eighteen tank cars are included in the program. Five cars are equipped with a jacketed thermal shield, and 13 cars are equipped with a spray-on chemical insulation coating. Most cars are equipped with head shield end-of-car protection systems. The goal of the tests is to simulate the effects of 10 years of normal service operations. This involves subjecting the cars to a large number of coupling impacts as well as running the cars for a mileage representative of the 10 year period.

79-1264

Rail Safety/Equipment Crashworthiness. Volume 1. A Systems Analysis of Injury Minimization in Rail Systems

M.J. Reilly, R.H. Jines, and A.E. Tanner

Boeing Vertol Co., Philadelphia, PA, Rept. No. DOT/TSC/FRA-77-15-1, 265 pp (July 1978)

PB-289 147/1GA

Key Words: Railroad cars, Collision research (railroad), Crashworthiness

The Transportation Systems Center is conducting technical analyses of passenger railcar collisions, derailments, and other accidents, directed towards minimizing occupant injuries. The document, the first of four volumes, reports on the collection of data for a representative accident sample, the analysis of the data to identify injury types, locations, and when possible, injury casual factors. Vehicle interior design details are also considered in conjunction with the accident data to compile a list of potential improvements in occupant protection.

79-1265

Rail Safety/Equipment Crashworthiness. Volume II. Design Guide

M.J. Reilly, J. Shefrin, and L.M. Patrick

Boeing Vertol Co., Philadelphia, PA, Rept. No. DOT/TSC/FRA-77-15-2, 99 pp (July 1978)

PB-289 148/9GA

Key Words: Railroad cars, Collision research (railroad), Crashworthiness

The second of four volumes has been prepared to assist design engineers in understanding the basic problems associated with the development of crashworthy interiors of locomotives, cabooses and passenger railcars. Rail vehicle accident conditions are presented with the resulting interactions that can occur between one car and another. Types of injuries to the occupants of the cars, and the mechanism causing the injury, are discussed.

79-1266

Rail Safety/Equipment Crashworthiness. Volume III. Proposed Engineering Standards

M.J. Reilly

Boeing Vertol Co., Philadelphia, PA, Rept. No. DOT/TSC/FRA-77-15-3, 70 pp (July 1978)

PB-289 149/7GA

Key Words: Railroad cars, Collision research (railroad), Crashworthiness, Standards and codes

The document, the third of four volumes, contains recommended Engineering Standards prepared in the format of the standards published in the Code of Federal Regulations (Title 49, Transportation, Parts 200). The standards proposed provide improved occupant protection in the secondary impact situation associated with railroad accidents.

79-1267
Rail Safety/Equipment Crashworthiness. Volume IV. Executive Summary
M.J. Reilly
Boeing Vertol Co., Philadelphia, PA, Rept. No. DOT/TSC/FRA-77-15-4, 75 pp (July 1978)
PB-289 150/5GA

Key Words: Railroad cars, Collision research (railroad), Crashworthiness

The document, the fourth of four volumes, summarizes the activities and documentation conducted under this contract. The analysis of the accident data highlighted areas where improvements could be made to improve the occupant protection of passenger rail vehicles. Design criteria are determined and some suitable design changes proposed. For the proposed areas of change, typical Federal Standards documentation are prepared.

79-1268
Dynamic Experiments of Alternative Guideway-Vehicle Systems, Part 1
J.F. Wilson
Dept. of Civil Engrg., Duke University, Durham, NC, Rept. No. DOT/RSPA/DPB/50-77/11, 110 pp (June 1978)
PB-288 244/7GA

Key Words: Rapid transit railways, Interaction: vehicle-guideway, Experimental data

This is an experimental investigation of vehicle-elevated guideway response dynamics. Descriptions are given of the laboratory system components, which are: the spans (single, multiple and cable-stayed); the vehicles (tandem point loads and an Automated Guideway Transit (AGT) vehicle model); the vehicles' linear induction motor propulsion systems; and the span vehicle data retrieval system. Data are presented for a variety of vehicle-guideway configurations. The last study summarizes current analyses on horizontal guideways of constant radius of curvature, and the response of such guideways to transit loads.

RECIPROCATING MACHINE

(Also see Nos. 1150, 1223)

79-1269
Reducing Noise Radiated by Diesel Engines
M.F. Russell
Lucas Industries Noise Centre, Noise Control Vib. Isolation, 9 (9), pp 385-386 (Nov/Dec 1978) 3 figs

Key Words: Diesel engines, Noise reduction

Four basic approaches to controlling noise radiated by vehicle engine surfaces are given and the relative importance of combustion noise and mechanical noise generators is discussed. A method of diagnosing the contribution to the overall noise of the engine from each surface area is also covered.

79-1270
Reducing Noise Radiated by Diesel Engines - Part 2
M.F. Russell
Lucas Industries Noise Centre, Noise Control Vib. Isolation, 10 (1), pp 5-7 (Jan 1979) 7 figs, 3 refs

Key Words: Diesel engines, Noise reduction

Methods for controlling road vehicle noise radiated by engine surfaces as they vibrate in response to the vibratory forces developed within engines are discussed. Treatments for crankcase and cylinder block as well as valve gear covers are given.

79-1271
Diesel Vehicle Noise Control
Auto Engr., 4 (1), pp 23-27 (Feb/Mar 1979) 12 figs, 1 table, 6 refs

Key Words: Noise reduction, Diesel engines

An account of the TRRL Quiet Heavy Vehicle project is followed by details of recent developments in diesel engine noise control at the Institute of Sound and Vibration Research, Southampton University, and of noise research on production engines at Perkins.

ROAD

(Also see Nos. 1169, 1217, 1252)

79-1272
Vehicle Integration and Evaluation of Advanced Restraint Systems. Volume 1: Phase A
R.W. Carr and G.M. Aboud

Dynamic Science, Inc., Phoenix, AZ, Rept. No. 8300-77-146, DOT-HS-802 829, 363 pp (Oct 1977) PB-288 930/1GA

Key Words: Collision research (automotive), Safety restraint systems, Crashworthiness, Seat belts, Air bags (safety restraint systems), Impact tests

The report presents the results of nine full-scale crash tests conducted to evaluate the performance of four advanced restraint systems; RSV Driver Airbag, RSV Passenger Airbag, Force Limited Airbelt, and the Force Limited 2-inch Belt, when structurally integrated into a production vehicle. The vehicle chosen by NHTSA for this is the Volvo 244. The tests consist of car-to-car and car-to-barrier impacts which are conducted to help determine the performance limits of the four advanced restraint systems in terms of meeting the FMVSS 208 crashworthiness criteria.

79-1273
Vehicle Integration and Evaluation of Advanced Restraint Systems. Volume II: Phase B
R.W. Carr and G.M. Aboud
Dynamic Science, Inc., Phoenix, AZ, Rept. No. 8300-77-147, DOT-HS-802 830, 224 pp (Oct 1977) PB-288 931/9GA

Key Words: Collision research (automotive), Safety restraint systems, Crashworthiness, Impact tests

A series of eighteen full-scale crash tests are conducted to evaluate the performance of four advanced restraint systems that are structurally integrated into the Volvo 244. These tests are split into two phases; Phase A consists of car-to-car and car-to-barrier impact tests using only Volvo 244's as test vehicles while the Phase B impact test configurations are car-to-car using Volvo 244's with Ford Torinos serving as bullet vehicles. This report presents the test results from Phase B of the test series.

79-1274
Vehicle Integration and Evaluation of Advanced Restraint Systems. Volume III: Phase C
R.W. Carr and G.M. Aboud
Dynamic Science, Inc., Phoenix, AZ, Rept. No. 8300-77-184, DOT-HS-803 594, 215 pp (Dec 1977) PB-288 932/7GA

Key Words: Collision research (automotive), Safety restraint systems, Impact tests, Anthropomorphic dummies

The objective of the program is to evaluate the performance of restraint systems in terms of meeting the FMVSS 208 injury criteria. In this phase of the tests, Ford Torinos are tested using instrumented dummies restrained by both standard and modified belt systems. The report presents the results of the tests.

79-1275
Front Passenger Aspirator Air Bag System for Small Cars. Phase II Evaluation
D.J. Romeo
Calspan Corp., Buffalo, NY, Rept. No. CALSPAN-ZP-5777-V-2, DOT-HS-803 612, 160 pp (Mar 1978) PB-288 873/3GA

Key Words: Collision research (automotive), Air bags (safety restraint systems)

Development and evaluation of an aspirator air bag has been completed at Calspan Corporation. The aspirator air bag is developed through computer simulations and sled tests, Phase I, and is evaluated through additional sled tests and in a 41.6 mph crash of a standard Volvo into a flat barrier. This report reviews the Phase I development of the aspirator system and presents results of the Phase II sled tests and the car crash.

79-1276
Steering Wheel Oscillations and Vertical Movement in 30 mph Barrier Impacts
A. Hill
Office of Passenger Vehicle Res., National Highway Traffic Safety Admin., Washington, D.C., Rept. No. DOT/HS-803 606, 130 pp (Sept 1978)
PB-288 455/9GA

Key Words: Collision research (automotive), Steering gears, Impact tests, Guardrails

Data relating to the column behavior of 41 vehicles - 1975 through 1977 year models - when subjected to a 30 mph barrier impact are obtained from the FMVSS No. 204 compliance test reports. Test films and associated data are analyzed to identify typical response patterns of steering assemblies. (Portions of this document are not fully legible).

79-1277
Commercial Vehicles and Road Surface Stress (Nutzfahrzeuge und Fahrbahnbeanspruchung)
F. Gauss
Linzer Strasse 1, 3000 Hannover, Germany, Automobiltech. Z., 81 (2), pp 43-47 (Feb 1979) 10 figs, 7 refs

Key Words: Commercial transportation, Ground vehicles, Interaction: wheel-pavement

The dynamic road surface stresses given by wheel load, type of tires, and vibration characteristics of the vehicles are determined. With the aid of an exponential law, a comparison figure is calculated according to the up-to-date experiences and with vehicle-dependent factors.

ROTORS

(See Nos. 1111, 1116, 1118, 1261, 1284)

SHIP

(Also see No. 1177)

79-1278
Noise Control in Ships
A.J. Jones and G. Berry
Acoustical Investigation and Res. Organization, Ltd., Noise Control Vib. Isolation, 9 (9), pp 371-375 (Nov/Dec 1978) 4 figs, 1 table, 9 refs

Key Words: Ships, Noise control

Noise rating criteria and the control of machinery noise on board is discussed.

79-1279
Hydrodynamic Analysis of a High-Speed Marine Towed System
D.E. Calkins
Systems Exploration, Inc., San Diego, CA, J. Hydronautics, 13 (1), pp 10-19 (Jan 1979) 12 figs, 4 tables, 12 refs

Key Words: Towed systems, Hydrodynamic excitation

The objective of this work is to develop a general model of a marine towed system and to verify its accuracy by comparison with full-scale towed system measurements. This model comprises a representation of both the towed body and towline. Fully instrumented trials of a full-scale towed system provided data for correlation with the model.

79-1280
Reliability Assessment of Offshore Platforms in Seismic Regions
J.N. Yang and A.M. Freudenthal
School of Engrg. and Appl. Science, George Washington Univ., Washington, D.C., Rept. No. NSF/RA-770660, 118 pp (Aug 1977)
PB-288 572/1GA

Key Words: Off-shore structures, Seismic response, Water waves, Stochastic processes

The purpose of this study is to present a method of reliability analysis and design for the offshore platforms under stochastic dynamic loads during their design service life. The present approach combines the analyses of nonlinear random vibration and the first passage probability. The reliability design is examined to establish the conditions under which the design for one loading condition, such as storm waves is sufficient, as well as the conditions under which both the storm waves and the earthquakes are given equal emphasis. The applied loads due to storm waves and earthquakes are modeled as stationary Gaussian random processes with zero mean and finite duration.

79-1281
Seismic Analysis of Offshore Structure Supported on Pile Foundation
D.D.-N. Liou
Ph.D. Thesis, Univ. of California, Berkeley, 104 pp (1978)
UM 7904524

Key Words: Off-shore structures, Pile foundations, Seismic response, Mathematical models, Interaction: structure-foundation

This report presents an analytical study of the seismic response characteristics of an offshore structure supported on pile foundations. A simple mathematical model of pile

foundation based on the three-dimensional theory of elasticity is developed. The earthquake surface ground motion is prescribed in the time domain, the solution of the system is carried out in the frequency domain, and the desired response quantities are transformed back to the time domain. Foundation-structure interaction effects are examined by comparing response quantities obtained for models with and without foundation flexibility.

TRANSMISSIONS

(Also see No. 1246)

79-1282

An Analytical Method for Designing Low Noise Helicopter Transmissions

R.B. Bossler, Jr., M.A. Bowes, and A.C. Royal

Kaman Aerospace Corp., Bloomfield, CT, in: NASA Langley Res. Ctr., Helicopter Acoustics, Pt. 2, pp 657-677 (Aug 1978)

N79-10859

Key Words: Helicopter noise, Transmission gears

The development and experimental validation of a method for analytically modeling the noise mechanism in the helicopter geared power transmission systems is described. This method can be used within the design process to predict interior noise levels and to investigate the noise reducing potential of alternative transmission design details. Examples are discussed.

79-1283

Transmission Design with Finite Element Analysis: Part 4

R.W. Howells

Power Train Tech. Group, Boeing Vertol Co., Philadelphia, PA, Power Transm. Des., 21 (3), pp 42-45 (Mar 1979) 25 figs, 8 refs

Key Words: Power transmission systems, Finite element technique, Computer programs, Optimization

A computer model of the CH-47 helicopter forward rotor transmission is developed and is used to optimize transmission design. The current effort is concentrated in two areas – to minimize overall vibration and noise levels and to optimize the housing structural design.

USEFUL APPLICATION

79-1284

Acoustic Driving of Rotor

H. Kanber, I. Rudnick, and T.G. Wang

NASA, Pasadena Office, CA, Rept. No. NASA-Case-NPO-14405-1; US-Patent-Appl-SN-812447, 9 pp (July 1977)

N78-22859

Key Words: Rotors, Propulsion systems, Acoustic techniques

The object of the invention is to provide a system for utilizing sound to rotate a suspended object, with large and controlled torque. An enclosure of square cross-section is utilized together with transducers at walls which are at right angles to each other.

79-1285

Vibration Responsive Switch

J.H. Watson

Dept. of the Navy, Washington, D.C., Rept. No. AD-D004 736/5, PAT-APPL-326 649, 6 pp (Mar 8, 1977)

PATENT-4 011 418

Key Words: Switches

The vibration responsive switch is comprised of a mass, a pair of support structures located on opposite sides of the mass, a taut wire attached to both of the support structures and to the mass, a switch armature mounted on the mass, and a fixed contact located in physical proximity to the armature.

79-1286

Vibratory Compaction of Asphalt Concrete

R.J. Nittlinger

Engrg. Res. and Dev. Bureau, New York State Dept. of Transportation, Albany, NY, Rept. No. RR-64, FHWA/NY-78/RR/64, 41 pp (Aug 1978)

PB-288 744/6GA

Key Words: Concretes, Pavements, Compacting, Vibratory techniques

Vibratory rollers, when operated properly, are found to be effective in compacting asphalt concrete. Also, rather than accept or reject rollers individually, operating criteria are developed to determine the ability of any roller to compact a given lift thickness.

79-1287

Dynamic Analysis of a Roller Coaster

J.N. Crisp

Univ. of Dayton, Dayton, OH, ASME Paper No. 78-DE-W-5

Key Words: Roller coaster, Safety devices

The present paper is concerned with the engineering dynamic analysis of selected safety devices and the car couplers on a roller coaster. A practical engineering approach is incorporated in the analysis with regard to the many physical boundary conditions required to develop a realistic model. The dynamic loading on the car couplers and an anti-rollback dog are determined for several different grades of track for the condition that the coaster, (five cars) on failure to top a particular grade, rolls back a given distance and strikes an anti-roll-back device.

AUTHOR INDEX

TECHNICAL NOTES

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J. Appl. Mech., Trans. ASME, 46 (1), p 213 (Mar 1979)

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Nonlinear Vibration of Rectangular Plates
J. Appl. Mech., Trans. ASME, 46 (1), pp 215-217 (Mar 1979) 2 figs, 6 refs

B.M. Karmakar
Amplitude-Frequency Characteristics of Large-Amplitude Vibrations of Sandwich Plates
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Appl. Math. Modeling, 3, p 75 (Feb 1979) 1 fig, 6 refs

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Engrg. Structures, 1 (3), pp 162-163 (Apr 1979) 7 refs

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CWPEEF's Views on Earthquake-Resistant Design of Earth Dams
ASCE J. Geotech. Engr. Div., 105 (GT1), pp 85-88 (Jan 1979)

S.K. Chakrabarti
Added Mass of Sphere Near Floor in Oscillatory Waves
ASCE J. Engr. Mech. Div., 105 (EM1), pp 191-195 (Feb 1979) 3 figs, 3 refs

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Nonlinear Dynamics of Tube in Coaxial Flow
ASCE J. Engr. Mech. Div., 105 (EM1), pp 196-199 (Feb 1979) 1 fig, 1 ref

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J. Mech. Des., Trans. ASME, 101 (2), pp 322-329 (Apr 1979) 13 figs, 4 refs

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J. Mech. Des., Trans. ASME, 101 (2), pp 317-321 (Apr 1979) 6 figs, 13 refs

Y. Ito, J. Toyoda, and S. Nagata
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J. Mech. Des., Trans. ASME, 101 (2), pp 330-337 (Apr 1979) 16 figs, 9 refs

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J. Mech. Des., Trans. ASME, 101 (2), pp 342-347 (Apr 1979) 10 figs, 2 tables, 8 refs

N. Ganesan and M.S. Dhotarad
Higher Modes of Transmission Lines with Dampers
J. Sound Vib., 63 (2), pp 297-300 (Mar 22, 1979) 2 tables, 9 refs

M.D. Rowbottom
The Effect of an Added Mass on the Galloping of an Overhead Line
J. Sound Vib., 63 (2), pp 310-313 (Mar 22, 1979) 1 fig, 1 table, 3 refs

C. Massalas, K. Soldatos, and G. Tzivanidis
Free Vibrations of Plates Subjected to Elastic Constraints and Initial Membrane Forces
J. Sound Vib., 63 (2), pp 303-306 (Mar 22, 1979) 3 figs, 3 refs

K.A. Afimiwala and R.W. Mayne
A Contour Plotting Scheme for Design Optimization
J. Mech. Des., Trans. ASME, 101 (2), pp 349-354 (Apr 1979) 8 figs, 1 table, 7 refs

CALENDAR

JULY 1979

9-13 **5th World Congress on the Theory of Machines and Mechanisms,** [ASME] Montreal, Quebec, Canada ***(ASME Hq.)***

AUGUST 1979

13-15 **Joint Automatic Control Conference,** [ASME] San Francisco, CA ***(ASME Hq.)***

28-31 **International Tire Noise Conference,** [National Swedish Board for Technical Development, STU] Stockholm, Sweden ***(International Tire Noise Conference, c/o Stockholm Convention Bureau, Strandvägen 7c, S-114 56 Stockholm, Sweden)***

SEPTEMBER 1979

21st Polish Solid Mechanics Conference [Polish Academy of Sciences, Institute of Fundamental Technological Research] Poland ***(Dr. Marek Elżanowski, Institute of Fundamental Technological Research, Świętokrzyska 21, 00-049, Warsaw, Poland)***

3-5 **Numerical Analysis of the Dynamics of Ship Structures,** Avignon, France ***(Dr. J.L. Armand, Institut de Recherches de la Construction Navale, 75008 Paris, France)***

9-14 **Petroleum Mechanical Engineering Conference** [ASME] Hyatt Regency, New Orleans, LA ***(ASME Hq.)***

10-12 **ASME Vibrations Conference,** [ASME] St. Louis, MO ***(ASME Hq.)***

10-13 **Off-Highway Meeting and Exposition** [SAE] MECCA, Milwaukee, WI ***(SAE Meeting Dept., 400 Commonwealth Dr., Warrendale, PA 15096)***

11-14 **INTER-NOISE 79,** [INCE] Warsaw, Poland ***(INTER-NOISE 79, IPPT PAN, ul. Świętokrzyska 21, 00-049 Warsaw, Poland)***

OCTOBER 1979

7-11 **Fall Meeting and Workshops,** [SESA] Mason, OH ***(SESA, 21 Bridge Square, P.O. Box 277, Saugatuck Sta., Westport, CT 06880 - Tel (203) 227-0829)***

16-18 **50th Shock and Vibration Symposium,** Colorado Springs, CO ***(H.C. Pusey, Director, The Shock and Vibration Information Center, Code 8404, Naval Research Lab., Washington, D.C. 20375 - Tel (202) 767-3306)***

16-18 **Joint Lubrication Conference,** [ASLE-ASME] Dayton, OH ***(ASME Hq.)***

17-19 **Stapp Car Crash Conference** [SAE] Hotel del Coronado, San Diego, CA ***(SAE Meeting Dept.)***

NOVEMBER 1979

4-6 **Diesel and Gas Engine Power Technical Conference,** San Antonio, TX ***(ASME Hq.)***

5-8 **Truck Meeting,** [SAE] Marriott, Ft. Wayne, IN ***(SAE Meeting Dept.)***

26-30 **Acoustical Society of America, Fall Meeting,** [ASA] Salt Lake City, UT ***(ASA Hq.)***

DECEMBER 1979

Aerospace Meeting [SAE] Los Angeles, CA ***(SAE Meeting Dept.)***

2-7 **Winter Annual Meeting** [ASME] Statler Hilton, New York, NY ***(ASME Hq.)***

FEBRUARY 1980

25-29 **Congress & Exposition** [SAE] Cobo Hall, Detroit, MI ***(SAE Meeting Dept.)***

MARCH 1980

9-13 **25th Annual International Gas Turbine Conference and Exhibit** [ASME] New Orleans, LA ***(ASME Hq.)***

APRIL 1980

21-25 **Acoustical Society of America, Spring Meeting** [ASA] Atlanta, GA ***(ASA Hq.)***

MAY 1980

25-30 **Fourth SESA International Congress on Experimental Mechanics,** [SESA] The Copley Plaza, Boston, MA ***(SESA Hq.)***

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AFIPS: American Federation of Information Processing Societies
210 Summit Ave., Montvale, NJ 07645

AGMA: American Gear Manufacturers Association
1330 Mass. Ave., N.W.
Washington, D.C.

AHS: American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA: American Institute of Aeronautics and Astronautics, 1290 Sixth Ave.
New York, NY 10019

AIChE: American Institute of Chemical Engineers
345 E. 47th St.
New York, NY 10017

AREA: American Railway Engineering Association
59 E. Van Buren St.
Chicago, IL 60605

AHS: American Helicopter Society
30 E. 42nd St.
New York, NY 10017

ARPA: Advanced Research Projects Agency

ASA: Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE: American Society of Civil Engineers
345 E. 45th St.
New York, NY 10017

ASME: American Society of Mechanical Engineers
345 E. 45th St.
New York, NY 10017

ASNT: American Society for Nondestructive Testing
914 Chicago Ave.
Evanston, IL 60202

ASQC: American Society for Quality Control
161 W. Wisconsin Ave.
Milwaukee, WI 53203

ASTM: American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

CCCAM: Chairman, c/o Dept. ME, Univ. Toronto, Toronto 5, Ontario, Canada

ICF: International Congress on Fracture
Tohoku Univ.
Sendai, Japan

IEEE: Institute of Electrical and Electronics Engineers
345 E. 47th St.
New York, NY 10017

IES: Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IFToMM: International Federation for Theory of Machines and Mechanisms, U.S. Council for TMM, c/o Univ. Mass., Dept. ME
Amherst, MA 01002

INCE: Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA: Instrument Society of America
400 Stanwix St.
Pittsburgh, PA 15222

ONR: Office of Naval Research
Code 40084, Dept. Navy
Arlington, VA 22217

SAE: Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096

SEE: Society of Environmental Engineers
6 Conduit St.
London W1R 9TG, UK

SESA: Society for Experimental Stress Analysis
21 Bridge Sq.
Westport, CT 06880

SNAME: Society of Naval Architects and Marine Engineers, 74 Trinity Pl.
New York, NY 10006

SPE: Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC: Shock and Vibration Information Center
Naval Research Lab., Code 8404
Washington, D.C. 20375

URSI-USNC: International Union of Radio Science - US National Committee c/o MIT Lincoln Lab., Lexington, MA 02173

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